

What Tempe Bicycle Advocates Can Learn from the Dutch:
Lessons from One of the World's Most Bicycle Friendly Cities

by

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A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Urban and Environmental Planning

Approved April 2015 by the
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May 2015

ABSTRACT

The city of Groningen in the Netherlands is often referred to as the "world cycling city" because over fifty percent of trips are made on bicycles (Van Hoven & Elzinga, 2009). On the contrary, just four percent of trips in Tempe, Arizona are on bicycles (McKenzie, 2014). Through a series of interviews and surveys, this study investigates what causes such high bicycling rates in Groningen and applies these findings to Tempe. The results suggest that Groningen experiences high bicycling rates because the city uses "carrot" and "stick" policies to encourage bicycling and discourage driving. It is therefore recommended that Tempe adopt both types of policies to raise bicycling levels.

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CHAPTER 1

INTRODUCTION

Many studies have drawn conclusions about the various benefits associated with bicycling. It is well known that bicycling is one of the most sustainable transportation modes (Pucher & Buehler, 2006). After all, bicycles emit virtually no greenhouse emissions, and require far less roadway and parking space (Pucher & Buehler, 2006). Furthermore, bicycling is an extraordinary form of cardiovascular exercise that improves both physical and mental health (Pucher & Buehler, 2006). The current obesity epidemic in the United States can be partially attributed to extensive car use. The U.S. Surgeon General specifically recommends more cycling for practical daily travel as an ideal approach to raising physical activity levels (Pucher & Dijkstra, 2003). Despite continued evidence regarding the health and sustainability benefits associated with bicycling, few changes have occurred on the physical infrastructure of American cities to make them more bicycle-friendly. Yet, over the past several decades, the Dutch national government has invested millions of dollars into bicycle infrastructure improvements throughout the Netherlands (Pucher & Dijkstra, 2003). This begs the question, why did the Netherlands make the investment to promote bicycling while the United States did not? The answer is simple: cultural differences.

Historically, the transit choice culture in the United States has been very different from the culture in the Netherlands. The sprawling nature of American cities and their typical lack of meaningful public transportation make it difficult to travel without a vehicle. Additionally the under-pricing of parking, gasoline and drivers' licenses makes driving significantly cheaper than the Netherlands. As a result, Americans rely heavily on

vehicular transportation. Americans typically experience a right of passage at age 16, when they are old enough to obtain a drivers license, because it finally means the freedom to leave home alone.

Dutch cities have a much more compact urban form, often making a car unnecessary. Consequently Dutch citizens often prolong obtaining a drivers license and sometimes never obtain one. From as early as the age of three, Dutch children are taught bicycling as a primary means of transportation. They do not have to wait to receive a driver's license to freely commute because they can travel on a bicycle throughout their city. Children in the Netherlands go through bicycle training in school to help familiarize them with traffic rules and behavior (Pucher, & Buehler, 2007). It should come as no surprise that 86 percent of all daily commutes in the United States are made in a car compared to just 48 percent of daily commutes in the Netherlands (McKenzie, 2014; Frulanu, et al. 2009). Furthermore, only 0.6 percent of daily journeys in the United States are made on bicycles compared to 26 percent in the Netherlands (McKenzie, 2014; Frulanu, et al. 2009).

However, the United States is currently experiencing an urban cultural shift led by the Millennial generation, those born between 1977 and 1995 (Gallagher, 2013). Through the choices they are making, Millennials are contributing to the rebirth of central cities, which for so long had been left vacant with the previous surge of baby-boomers moving to suburbs. According to the Urban Land Institute, there is an increasing appetite especially among Millennials for higher density living patterns (Urban Land Institute, 2012). Recent trends in the housing market are a testament to this cultural shift. In 2011, the largest cities in the US grew more quickly than their combined suburbs. For the first

time in 50 years, there was a net population inflow into New York as the population within a two-mile radius of the city hall grew by nearly 40 thousand (Gallagher, 2013). The 2010 census revealed that the Philadelphia population grew for the first time in 60 years (Gallagher, 2013). Similar trends are happening in cities across the United States including Providence, Rhode Island, Austin, Texas, and Boston, Massachusetts (Gallagher, 2013).

The housing market in the Phoenix region is also adjusting to the new housing demands of Millennials. The skylines of the downtowns of Phoenix, Scottsdale and Tempe are filled with cranes building new mixed-use high-rises for residents. The last time this many apartments or condos were being built in Scottsdale was in the 1950s (Allhands, 2015). The same can be said for downtown Tempe. In May of 2014, Tempe voters approved the city's updated General Plan, which promotes sustainable urban living and high-density development (Nañez, 2014). There are 20 new high-rise developments underway in Tempe. The cultural shift we are experiencing in the United States may signal the end of the suburbs as we know them (Gallagher, 2013).

Millennials also are contributing to the end of the driving boom, a sixty-year long period of steady increases in per-capita driving in the United States. Millennials prefer to have options rather than commute long distances. Four in five Millennials say they want to live in places where they have transportation choices including walking, taking public transportation or bicycling (Rodin, 2014). These demands are already reflected in the recent decline in car sales. Studies have shown that Millennials are not buying cars at the same rate as their parents. In 2010, adults between the ages of 21 and 34 bought just 27 percent of all new vehicles sold in America, which is down from the peak of 38 percent

in 1985 (Gallagher, 2013). Furthermore, the proportion of teenagers with a license fell by 28 percent between 1998 and 2008 (Thompson, & Weissmann, 2012).

However many cities throughout the United States are still characterized by extensive sprawl, which renders motor vehicles as the only transportation option. The city of Tempe, Arizona is one of those places. Tempe is part of the greater Phoenix region, which is the epitome of a traditional American city. The majority of trips in the region, which consists of extensive sprawl and suburban development, are made in vehicles. The lack of transportation options in Tempe conflicts with the ongoing cultural shift in the United States. It is vital for the economic development of Tempe to evolve to meet the new transportation demand of the Millennials. One of the transportation options that can be improved in Tempe is bicycling. By examining the high bicycle ridership rates in the Netherlands, much can be learned and ultimately applied to Tempe.

This thesis focuses on the city of Groningen, Netherlands as a best practice case. Through a series of interviews and surveys, this thesis attempts to identify the physical and personal factors that influence bicycle ridership among Millennials within Groningen. The question this thesis attempts to answer is: What are the physical and personal factors influencing bicycling among Millennials in the city of Groningen and which of these can be applied to increase bicycling among Millennials in the city of Tempe? The next section focuses on past research conducted on the determinants of bicycling and explains how this thesis contributes to the already existing field of research.

CHAPTER 2

LITERATURE REVIEW

Recently U.S. transportation planners began seeing biking as a legitimate mode of transport to be seriously considered in cities (Southworth, 2005). Since then, numerous studies have examined the relationship between physical infrastructure and biking behavior, with the goal of identifying planning interventions to promote bicycling. Depending on the study, various methods were used to achieve this goal. This section reviews the findings from this emerging body of work and identifies gaps in knowledge.

Some studies focused primarily on bicycle and pedestrian connectivity using physical distance measures. One study concluded that by using mapping software to find the most direct and shortest routes for pedestrians and bicyclists, neighborhood residents would have a larger incentive to reduce car trips (Randall & Baetz, 2001). Other studies examined the relationship between cycling and the built environment using data on cyclists, cycling behavior and detailed GIS-based measures of land use and infrastructure. One study found that within a neighborhood in King County, Washington, 21 percent of respondents reported cycling at least once a week (Moudon, et al. 2005). More often bicycling was used for recreational rather than transportation purposes. This study concluded that cycling is more popular among male, younger adults, transit users and those who are physically active and in good health (Moudon, et al. 2005).

Some studies took a different approach by examining which demographics were more sensitive to the built environment when making a decision to travel. For example, one study examined the travel behavior of over 700 participants from 36 environmentally diverse, but equivalent-sized neighborhoods (Forsyth, et al. 2008). Each respondent was

assigned to keep a 24-hour diary of travel and wear an accelerometer for seven days. The study found that most subgroups of people used the car less in high-density areas; however, only more obese individuals walked more overall in high-density areas after controlling for socio-demographic limitations (Forsyth, et al. 2008). A similar study, which aimed to analyze the daily travel activities of household members, looked specifically at the influences of urban designs, land-use diversity and density patterns on the choice to bicycle (Cervero & Duncan, 2003). This study applied the “3D” principle (density, diversity and design) to associate travel choices with built environments. The study used the 2000 Bay Area Travel Survey (BATS), containing up to two days of daily activity information of 15,066 randomly selected households in nine counties around San Francisco. The study concluded that urban landscapes in San Francisco have a generally insignificant effect on walking and bicycling. Even though well-connected streets, small city blocks and mixed land uses along with close proximity to retail activities have been shown to induce non-motorized transport, various exogenous factors such as topography, darkness and rainfall had far stronger influences (Cervero & Duncan, 2003). One study conducted a regression analysis using data from Canada and United States. It concluded that Canadians cycle about three times more than Americans for a variety of reasons including higher urban densities, mixed-use development, shorter trip distances, lower incomes, higher costs of owning, driving and parking a car and safer cycling conditions (Pucher & Buehler, 2006).

Several studies specifically examined differences in cycling behavior by gender by conducting counts at intersections to compare the cycling rate between males and female. For example, one study quantified the rate at which women and men bicycled

through specific intersections in order to roughly capture the trend for an entire city (Garrard, et al. 2007). The findings were consistent with gender differences in risk aversion because female cyclists preferred to use routes with maximum separation from motorized traffic. As a consequence of a lack of separated bicycle paths, this study found that male cyclists outnumbered females by a ratio of nearly four to one. (Garrard, et al. 2007).

Overall the studies described above are limited in scope because they focus solely on the built environment, infrastructure and demographics as determinants of bicycling. They neglect to consider how these characteristics interact with personal motivation and attitudinal influences on individuals' travel behavior (Dill, et al. 2014). A more recent body of literature applies the theory of planned behavior (TPB) to evaluate the relationship between attitudes and psychological factors and their relationship with individual transportation choices. Three types of considerations guide TPB. These include beliefs about (1) the likely consequences of behavior (behavioral beliefs), (2) the normative expectations of others (normative beliefs), and (3) the presence of factors that may further or hinder performance of the behavior (control beliefs). The more favorable the attitude, and subjective norm and the greater perceived control, the stronger the person's intentions to perform the behavior in question (Ajzen, 2010).

A recent study examined how TPB influences individual transportation choices (Dill, et al. 2014). This study was more comprehensive than the others mentioned above because it not only took the physical infrastructure into account in exploring the determinants of bicycling but also analyzed how the physical infrastructure interacted with TPB. The study's methods consisted of a series of phone interviews with citizens

regarding their personal attitudes about various aspects of bicycling and the built environment. The goal was to speak with individuals of all ages and backgrounds. The study had several conclusions. First, it found that the built environment is an important influence on behavior because it shapes people's perceived behavior control, which helps predict their travel behavior. Second, it found that social norms do not play a significant role in walking and bicycling behavior. Third, it found that demographics are an important influence on the psychological factors and thus travel behavior. For example, older adults in the study had more negative attitudes towards bicycling. The conclusions drawn from this study are overall more comprehensive than those drawn from the studies mentioned above because they explain how the physical environment influences personal behavior and attitudes.

Other studies have managed to integrate research on the relationship between the physical environment and personal decisions to bicycle from an international perspective. For example, one study undertook a comprehensive search of peer-and non-peer reviewed research on this topic, resulting in a sample of 139 studies (Pucher, Dill & Handy, 2010). The research developed a hypothesized list of environmental interventions that influence people's decision to bicycle. These interventions include infrastructure (e.g. bike lanes and parking) as well as integration with public transportation (Pucher, Dill & Handy, 2010). Its findings suggest overall positive impacts of interventions on bicycling levels. However, the results revealed considerable variation in estimated impacts depending on the type of intervention making it difficult to generalize about the effectiveness of particular interventions. Furthermore, this study neglected to include

important and relevant measures such as congestion pricing, gasoline taxation, and car parking policies on bicycling behavior (Pucher, Dill & Handy, 2010).

The studies listed here have all contributed to the growing literature on the determinants of bicycling in cities. Nonetheless, many of these studies have fundamental limitations. First, most of the studies discussed above investigate bicycling influences in North American cities where the bicycling rate is already very low. For example, one study mentioned above conducted a comparison between cities in Canada and the United States (Pucher & Buehler, 2005). However the bicycle rate in these countries is 1.2 percent (Pucher & Buehler, 2005) and 0.6 percent respectively (McKenzie, 2014). Instead of examining cities with negligible bicycling rates, this thesis takes a fundamentally different approach by first examining a best practice city in the Netherlands and applying its findings back to the United States.

Furthermore, the vast majority of existing research surrounding bicycle promotion examines the physical infrastructure and the built environment but fails to consider how these components influence personal mode choice. This study takes both components into account to provide a more comprehensive view of bicycling influences. Although some studies analyzed the influence of the physical environment on personal mode choice, their findings neglected several key factors. For example, Pucher, Dill & Handy, 2010 neglected to consider how the costs associated with car ownership influence bicycling.

The study conducted by Dill, et al. also has several limitations. The majority of the surveys conducted in this study were with individuals above the age of 55 (Dill, et al. 2014), thus hindering conclusions that could be drawn about Millennials. This study also neglected to draw on the expertise of transportation planning professionals and professors

regarding their opinion about physical changes that should be made to promote bicycling (Dill, et al. 2014).

Moreover, the methodology of research that considered both physical and personal influence was limited to surveys or referencing past literature. The data collection of this study employs both surveys and previous literature in addition to personal observations and supplemental interviews with planning professionals. The methodology is explained more thoroughly in the next chapter.

CHAPTER 3

DATA AND METHODS

Research Objectives

The following are the main objectives of this research:

1. Examine the factors that contribute to high levels of biking among Millennials in Groningen.
2. Conclude which of the factors are most powerful.
3. Using lessons from Groningen, strategize how to cultivate conditions that lead to biking among Millennials in Tempe.

To achieve these objectives, this research is divided into three parts.

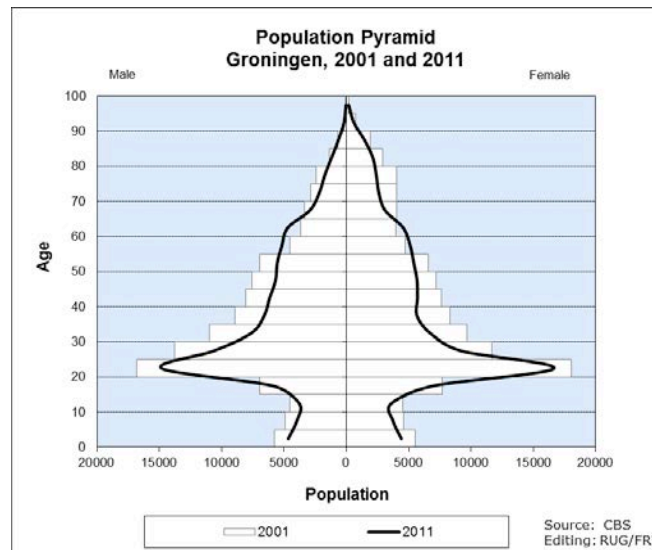
Part 1: Selection of Case Study

Arizona State University's relationship with the Network for European and U.S. Regional and Urban Studies (NEURUS) provided me with a link at the University of Groningen (RUG) allowing me to work with a local professor at the institution. NEURUS is an international consortium of universities dedicated to the collaborative study of urban and regional development issues. Its use of distance learning, faculty and student exchange as well as transcontinental seminars allowed me to choose Groningen as a study and data collection location. Furthermore given that Groningen has one of the highest rates of bicycling trips in the world, its uniqueness provided valuable data to draw lessons from and thus justified conducting a case study in that city.

The population compositions of Groningen and Tempe have many similarities. Since the population composition of a city has a profound effect on its bicycling rates

(Van Steen, 2014) much of the data collected in Groningen could be applied to Tempe. Groningen has a population of 198 thousand (Van, Steen, 2014), and Tempe has a current population of 169 thousand people (U.S. Department of Commerce, 2013). According to the U.S. Census Bureau, Groningen and Tempe would be classified in the same category of “Medium-Sized Cities” with populations between 100 thousand and 199 thousand residents (McKenzie, 2014). Moreover, both cities contain large student populations, as they are home to large universities. Tempe’s Arizona State University annually enrolls 70 thousand students (Keeler, 2013). Between The University of Groningen and Hanzehogeschool, 60 thousand students study in Groningen (Interview, Vissers, 2014). Forty-eight percent of Tempe’s population is under 34 years old (U.S. Department of Commerce, 2012) As can be seen from Figure 3.1 Groningen’s population also consists of mainly of young people in the same age-range.

Figure 3.1: Population Composition of Groningen



Because of the two large universities in Groningen, the majority of the population is comprised of young adults from the ages of 18-30 years
Source: Herbers, 2014

Part 2: Contextual Research

First I conducted a content analysis on the respective historical culture, politics and structural events of Groningen and Tempe from a variety of literature sources and interviews to provide a context for how these events influence current travelling behaviors in each city. I consulted several historical books written about the Phoenix region and applied this literature in the context of Tempe's history. Unfortunately many of the literature resources on the history of Groningen were written in Dutch. Therefore my contextual research in Groningen was based mostly on the finished dissertation of Shinji Tsubohara, which provided a comprehensive historical overview of Groningen's culture and politics surrounding its development. I gained additional historical insight during the interviews I conducted with various Dutch professors and planners.

Part 3: Primary Data Collection

This study employed a qualitative methodology using both an inductive and deductive approach. The data collection had three components. These components were: (1) surveys aimed at younger Groningen residents (Millennials) ages 18-30, (2) interviews with transportation experts and (3) observations of the bicycling infrastructure.

Surveys

The surveys were aimed at understanding Millennials' personal motivations for biking in Groningen. To best understand these motivations, two types of commuters were surveyed: those who biked the entire trip, and those who biked and used public transportation. All respondents were asked their age to ensure that each individual was between the age of 18 and 30 (the age range of Millennials). All respondents took the same

survey. Table 3.1 depicts respondents' mode of transportation, occupation, trip purpose and times per week they use their particular mode for that particular trip.

Table 3.1: Respondent Background Information

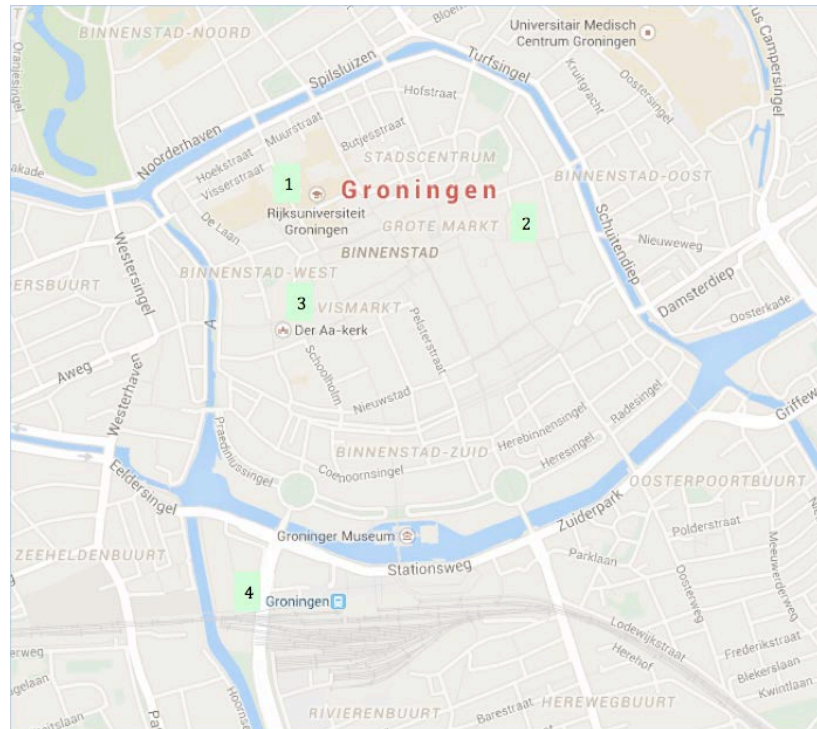
Mode of transportation	
Bike	94%
Bike + Bus	2%
Bike + Train	4%
What are you?	
Working person	10%
Student (at RUG or Hanze)	90%
Purpose of trip	
Going to work/school	71%
Going to a restaurant or bar	10%
Shopping/groceries	15%
Recreation/exercise	4%
Time per week using this mode	
Rarely	3%
Sometimes	9%
Often	45%
Very often	43%

Source: Author

The majority of respondents used a bicycle as their only mode of transportation. Most the respondents were students or working individuals, which was not surprising given the age range of those surveyed included only Millennials. The purpose of each trip varied considerably and thus portrays that Millennials in Groningen used a bicycle for a variety of tasks. Most respondents used a bicycle either often or very often for their respective trips.

The surveys were distributed at varying times during the day over a series of four weeks. The purpose of conducting surveys at different times during the day allowed for interception of different commuters. For example, the majority of respondents on a weekday morning consisted of commuters going to work or school while the respondents on a Friday evening were those going to a restaurant or bar. Surveys were distributed at the following four locations in Groningen:

Figure 3.2: Survey Distribution Locations



**The four locations above are the areas where the surveys were distributed to Groningen residents.
Source: Google Maps**

1. Rijksuniversiteit Groningen- The University of Groningen city center campus was a prime location for survey distribution. Each day hundreds of students bicycle to class and the library at this campus. As can be seen in Image 3.1, there is ample bicycle parking at this location. Individuals were asked to partake in the survey during the time they walked to and from their bicycles into the building.

Image 3.1: University of Groningen City Center Campus



The University of Groningen city center campus was used as a survey distribution location.

Source: Author

2. Grote Markt- The “large market” was also located in the city center of Groningen. Surveys in the Grote Markt were distributed at various times each day because of the areas eclectic mix of travelers. For example, during the day, most travelers were going shopping while at night many were going to restaurants. Images 3.2 and 3.3 show the various uses of the Grote Markt.

Image 3.2: Grote Markt (Martini Tower)



The Grote Markt (big market) was used as a survey distribution location. The various markets, bars and social outlets located throughout the area brought an eclectic mix of travelers which helped to diversify individual reasons for commuting on the surveys
Source: Author

Image 3.3: Grote Markt: City Square



3. Vismarkt- The “fish market” was the final survey distribution area located in Groningen’s city center. The majority of travelers in the Vismarkt were there for shopping. An open-air market was setup in the square every Tuesday, Friday and Saturday. These were optimal times to seek respondents for the survey. Image 3.4 shows the various open-air shops as well as shopping in the surrounding buildings which brought many travelers to the area.

Image 3.4: Vismarkt



The Vismarkt “fish market” was the third survey distribution location in the city center. Most respondents were there for shopping

Source: Author

4. Groningen Central Station- Because a significant amount of workers and students in Groningen live outside of the municipality, many of them commute each day through Groningen Central Station. For this reason, this area served as an important survey distribution point because commuters of all kinds used various transportation methods including bicycle, train or bus. Surveys were distributed at the stations' bicycle parking facilities (Image 3.5) the bus stops (Image 3.6) and the train stops (Image 3.7).

Image 3.5: Groningen Central Station (Bicycle Parking)



Images 3.5, 3.6 and 3.7 are all at Groningen Central Station. Commuters use a combination of bicycles, buses and trains to commute to and from the station from within the municipality of Groningen as well as other cities and provinces. This was an important location for survey distribution because of the wide variety of commuters.

Source: Author

Image 3.6: Groningen Central Station (Bus stops)



**Image 3.7: Groningen Central Station
(Trains)**



An online survey was also available for residents as well. Groningen has many community Facebook pages with several thousand members. Posting the survey to these pages yielded significant results. Sixty percent of all survey results were obtained through online participation. The age of online respondents was controlled and those who were not in the age range of a Millennial were discarded from the sample.

Using a visual ladder, respondents rated the influence of eleven factors on their personal decision to ride a bike for a single trip. The ladder was based on a scale of 1 to 5 (1 having no influence, and 5 having extreme influence). The aggregation of responses represents the rank of importance of each factor at the sample level. For purposes of this study, the eleven factors being tested have been divided into the following four categories:

1. **Economy** encompasses the factor of *cost savings*
 - a. *Cost savings*- The typical new car in the United States costs \$30 thousand and sits in a garage or parking spot for 23 hours a day (Thompson & Weissmann, 2012). Besides the initial purchase price, there are many other costs associated with owning a car including: insurance, gas, maintenance and depreciation in value. The expenses associated with car ownership may have an influence on individuals' decision to bicycle instead of drive.

2. **Urban form** encompasses five factors including *time, distance, safe bicycle infrastructure, bicycle parking, and coordination between public transportation and bicycle transportation*.
 - a. *Time and distance*- Groningen has optimized the overall speed and convenience of bike travel by increasing the directness of bike trips and reducing trip distances for cyclists. Furthermore the city has created many dead ends, traffic-calmed areas and car-free zones making it inconvenient and less efficient to drive a car in Groningen (Pucher & Buehler, 2007).
 - b. *Safe bicycle infrastructure*- One important reason for the high rates of biking not only in Groningen but also throughout the Netherlands is a high level of safety for cycling compared to other countries. Between the years of 2002 and 2005, the number of bicycle fatalities per 100 million km cycled was 1.1 in the Netherlands as compared to 5.8 in the United States (Pucher & Buehler, 2007). This safety can be attributed to infrastructure features including separate bike paths from the street and bicycle crossing signals at intersections.

- c. *Bicycle parking*- Bicycle commuters want to park their bicycles quickly and closely to their destination. Free parking on the periphery of pedestrian zones tempt many cyclists to leave their bicycles there rather than further from their destination (Huizinga, 2009).
 - d. *Coordination between public transportation and bicycle transportation*- The bicycle can be used for pre- or post-transportation journeys over a long distance in combination with public transportation. The combination allows the commuter to bicycle from their front door to the bus stop or train station. The public transportation then takes the commuter over a long distance to another station so that he may bike the rest of the way to the final destination (Huizinga, 2009). This multi-modal coordination has been implemented in Groningen with extensive bike parking at train stations and some key bus stops. Furthermore, suburban rail services permit bikes on trains, which may influence individuals to take the train as opposed to driving into town (Pucher & Buehler, 2007).
3. **Comfort** encompasses *weather, relaxation and the possibility of bicycle theft*.
- a. *Weather*- Poor biking weather has been found to be strongly influential for bicyclists. Poor weather may include cold and hot temperatures, rain, snow and wind (Winters, et al, 2010).
 - b. *Relaxation*- About 70 percent of Dutch enjoy biking for relaxation (Huizinga, 2009).
 - c. *Possibility of bicycle theft*- The Netherlands is notorious for high rates of bicycle theft. In fact, some 750 thousand bicycles are stolen in the Netherlands

every year (Huizinga, 2009). As a result, “fear of theft and vandalism leads to lower bicycle use” (Huizinga, 2009, p. 67). Nonetheless, there are now seven guarded parking facilities located around the City of Groningen to help reduce theft. The possibility of bike theft may have a significant influence on individuals’ decision to bike (Pucher & Buehler, 2007).

4. **Health** encompasses “*being green*” (*sustainable*) and *exercise*.
 - a. “*Being green*” (*sustainable*) – According to Huizinga (2009), “the bicycle is the cleanest, most sustainable...mode of urban transport” (p. 22). When compared to the car, with regards to greenhouse gas emissions, the bicycle is 100 times more sustainable than the car (Huizinga, 2009).
 - b. *Exercise*- Lack of physical exercise has caused obesity in many developed nations. Around 11 percent of the population of the Netherlands is medically obese (Huizinga, 2009). Almost 36 percent of Americans are considered obese (National institute of diabetes and digestive and kidney diseases, 2012). Lack of physical exercise often leads conditions such as coronary and vascular diseases, as well as diabetes. Doctors agree that just half an hour of moderate biking a day is sufficient exercise to achieve a healthy lifestyle (besides a healthy diet) (Huizinga, 2009).

Interviews:

During my time in Groningen, I used a snowball sampling method to conduct a total of six one-on-one interviews over a period of two months with various professors in the Faculty of Spatial Sciences at the University of Groningen and planning professionals at the municipality of Groningen. These interviews focused on how physical components

of land use influence bicycling in Groningen. The diverse professional backgrounds of the interviewees provided unique land use planning perspectives on how the environment influences bicycling.

Based on the information collected from the interviews in Groningen, three subsequent interviews were conducted with ASU planning professors in Tempe, as well as the bicycling planner for the City of Tempe, which assisted in generating a set of policy recommendations for Tempe. Not all of the information discussed in Groningen was relevant in constructing policies to encourage bicycling among Millennials in Tempe, so the follow-up interviews in Tempe were important in deciphering the relevant data. The answers given from the interviews correspond with the data collected from the surveys to portray the interaction of Groningen's physical infrastructure with individuals' personal motivations to bicycle. Therefore the survey results (understanding personal influence) are mixed with the answers given from the interviews (understanding physical influence). The professional and academic background of each individual interviewed is provided in the appendix.

Observations:

Observations of the bicycle infrastructure were made in Groningen and Tempe. The primary goal was to understand how Groningen planners successfully designed the city to favor the bicycle as safe means of transportation and to see how this could be applied to the existing infrastructure in Tempe. Bicycle lanes were examined at two types of locations in both cities: intersections and along the sides of streets. Three safety characteristics of the bicycle lanes were examined: width, distance from the street and relationship with intersections. Further observations focused on the level of integration

with bicycles and public transportation. The objective was to compare the bicycle parking availability at train and bus stations as well as the features for travelers to bring bicycles with them on these modes of transportation. Photographs are included with this thesis to illustrate how to successfully implement these bicycle infrastructure features.

Part 4: Analysis and Conclusions:

I analyzed the data using qualitative coding as the primary form of analysis. A combination of manifest and latent methods were used to determine which factors were most influential to the bicycling behaviors of people living in Groningen. By triangulating the findings from the surveys, expert interviews, observations and secondary data drawn from past literature I synthesized my findings and made recommendations for Tempe.

Limitations:

This research has some limitations. The first limitation is the language barrier. Dutch is the official language of the Netherlands, so some respondents were unable to speak English. Nonetheless, this proved to be an insignificant problem for two reasons. First, 90 percent of Dutch citizens can speak English as a second language so most people I encountered during survey distribution could understand me (European Commission, 2012). For those unable or unwilling to speak English, an additional survey was provided in Dutch.

The second limitation is participation. This proved to be the most significant barrier. Many people felt uncomfortable, did not have the time or were simply uninterested in taking the survey. While distributing surveys on the street, approximately

25 percent of individuals agreed to partake in the survey. Nonetheless, the goal of obtaining 115 participants was achieved.

CHAPTER 4

HISTORY

Introduction

Cities around the world are unique. This statement is obvious but what is not so transparent are the historical factors that mold cities into their current physical urban form. For example, when it comes to urban form, Tempe Arizona has little in common with the city of Groningen, Netherlands. Besides the obvious geographical and climactic differences between the two cities, the historical past of these two places has a profound impact on their current urban forms. More specifically, Tempe is part of one of the most sprawling metropolises in the United States, while Groningen is one of the densest cities in the Netherlands.

The level of urban sprawl and urban density has a profound impact on commuting behaviors within a city (Geurs & van Wee, 2006). A dense city means less distance to travel in order to reach a destination. The closer a destination, the less likely a commuter will use a car to get there. For example, Groningen's high level of density promotes high bicycle usage throughout the city. In fact, over 50 percent of the trips in Groningen are made on bicycles (Van Hoven & Elzinga, 2009). Conversely, the sprawl of Tempe and the surrounding regions discourages bicycle ridership. Just 4.2 percent of the trips in Tempe are made on bicycles (McKenzie, 2014).

The question is, what historical influences have molded the disparate levels of density between Groningen and Tempe? This chapter aims to address the historical influences including political decisions, events and policies that have molded the modern day densities of Tempe and Groningen and how this has influenced the commuting

decisions of the residents. Because the city of Tempe is part of the greater Phoenix area, the overall history of Phoenix will be discussed in this paper because that has directly impacted the level of density in the city of Tempe.

Tempe/Phoenix

The fundamental reason for the extensive level of sprawl seen in Phoenix today goes back to people's motivations to move there in the first place. Phoenix has traditionally been regarded as an escape from the typical densely congested cities of the Northeast. The wide-open space, vast amount of cheap land and warm climate in Phoenix has lured millions of people into the area in search of their own piece of the paradise. In fact, at one point, Phoenix was regarded as the "anticity" because its vast sprawl diverged from traditional cities such as New York or Chicago (Luckingham, 1989). According to one observer, modern Americans "desired not a unified metropolis but a fragmented one" (p. 9). However, Phoenix was not always seen as a desirable place to live. Early settlers even actively avoided the area. To fully understand Phoenix today and the sprawl that comes with it, it is best to examine the city from its inception.

In the Beginning

Phoenix's roots can be traced all the way back to B.C. 1300. The Hohokam Indian tribe decided to establish a desert community with the extensive use of irrigation canals. These canals stretched for hundreds of miles, bringing water from surrounding rivers. The canals were successful, but the Hohokam eventually mysteriously disappeared from the area (Luckingham, 1989). Phoenix remained unoccupied for several centuries subsequent to the disappearance of the Hohokam. Other cities in the southwest region such as Santa Fe, Paso del Norte, Albuquerque and Tucson were developed under

Spanish rule. Despite the surrounding growth, Phoenix remained undisturbed. Even during the gold rush of the 1850s and 1860s, prospectors and other settlers avoided Phoenix. By the end of the civil war in 1865, the Phoenix area continued to contain only the canal remnants and residential ruins of the ancient Hohokam. However, over the following one hundred years, this relatively undisturbed land would soon become part of the ninth largest city in the United States by 1980 (Luckingham, 1989). Because Phoenix grew so quickly in such a short period of time, regulation and planning for the region was almost nonexistent. Furthermore, the wide availability of land and open spaces further contributed to fragmented development, setting the course for the region's modern-day sprawl.

Escaping the City for a Good Price

The industrial revolution in the late nineteenth century brought on the feeling that the Victorian city of industry was a threat to the physical and spiritual health of its inhabitants, raising mortality and reducing the quality of life. As a result, many people desired to live in decentralized and suburban communities because they felt these areas would foster a healthier living environment without the congestion of living in a city (Ross, 2011). It was this mentality that put Phoenix on the map and got people thinking about heading West to start a new, healthy life. Not only was the quality of life in Phoenix better, it was cheaper too. The United States Federal Government jump-started westward expansion through two federally subsidized programs. The Homestead Act of 1862 allowed citizens to purchase 160 acres of land for ten dollars. The 1877 Desert Land Act provided 640 acres for \$1.25 per acre. Within just a few years, thousands of discontented Eastern wage laborers jumped on the bandwagon were Phoenix bound

(Ross, 2011). The allure of Phoenix as a healthier environment combined with cheap land created the perfect combination to boost its growth.

Introducing the Car

The allure of the fragmented city and wide availability of cheap land enticed thousands of immigrants to move to Phoenix in the late 19th century. However, Phoenix still remained relatively dense at the time because people had to either walk or use the streetcars (Luckingham, 1989). A sprawling city is not conducive for walking or streetcars because both modes are too slow for travelling long distances.

Nonetheless, the urban form of Phoenix quickly changed with the introduction of the automobile in 1900. This new invention meant that people no longer were obliged to stay close to the city center and could take advantage of land even further away from downtown. Furthermore, the introduction of the Model T in 1908 meant cars were not restricted to the wealthiest citizens. The demand for automobiles in Phoenix was so high that in 1913, there were already 10 car dealerships in the city (Luckingham, 1989). The introduction of the automobile was the technology Phoenicians were waiting for. It helped people achieve their dream of living in a decentralized fragmented city. It was finally possible to build a single-family detached home far away from the discomforts of a bustling inner city and enjoy the comforts of suburban sprawl (Luckingham, 1989).

Thanks to the availability of the automobile, streetcars rapidly lost customers during and after the 1920s. Drivers wanted them off the road because they were in the way and backed up traffic. By the end of World War I there was no federal transit funding for streetcars at all. Suburban arterials grew wider and straighter making it more efficient than ever to travel long distances through the city (Ross, 2011).

Appeal of the Sun and the Sprawl

By the early 20th century, the popularity of Phoenix was growing tremendously. The extensive availability of cheap land and now the introduction of the automobile meant people could live in suburbia but also have access to the city. However, despite these attractions, nothing has influenced the growth of metro Phoenix more than the sun's rays. The region's 334 days of annual sunshine has been a primary draw for newcomers (Ross, 2011). The sunny, warm climate was a large attraction for both tourists and those wanting to escape the cold cities of the northeast and Midwest. Phoenix's climate was so attractive that doctors found many health benefits of living there. They often sent tuberculosis patients to Phoenix to seek respiratory relief because it was a perfect way to get out of the smog filled inner cities of the Northeast. As people visited Phoenix in search of warmer weather and cleaner air, many decided to stay permanently (Ross, 2011).

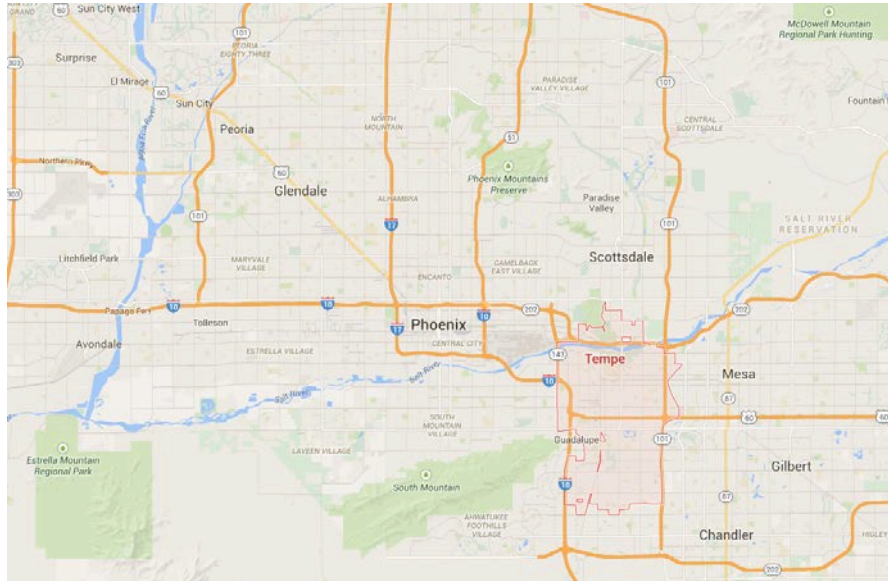
Postwar Suburb

The most significant growth and sprawl of Phoenix didn't start until after World War II. After the war, the urban form of cities in the United States and Europe diverged, with sprawl being much more visible in the United States. This divergence happened for two main reasons. First, after World War II, Europe was in shambles, and therefore many European cities had to be rebuilt from the start. This provided public planners with the opportunity to exercise a great deal of new authority and influence on the growth of European cities (which is exactly what happened in Groningen and will be described shortly). Second, while many countries in Europe were decimated by the war, the economy of the United States was thriving (Bruegmann, 2006). The long work hours,

high union wages and shortages of consumer goods during the war meant that American consumers had savings to spend. Furthermore, the end of World War II meant that the thousands of returning soldiers were ready to start families and many of them did. During the post-World War II baby boom, the United States experienced 18 years of elevated fertility rates. In 1946 there were approximately 2.4 million baby boomers and by 1964, that figure had reached 72.5 million (Colby & Ortman, 2014). The baby-boomers caused the population of the United States to jump from 150 million people to over 200 million people in the first two decades after the war. As a result of the drastic increase in births during that time, in no sector of the economy was there more pent-up demand than for housing (Ross, 2014).

The United States booming economy and a swiftly growing population led to the rapid and under-regulated growth of many American cities. The availability of single-family homes in 1946 was 50 percent higher than in 1941 and, in the next four years, nearly doubled again (Ross, 2014). The Phoenix area alone grew fourfold (Bruegmann, 2006). This resulted in a sharp reduction of densities and significant growth in urban areas that were low in density (Bruegmann, 2006). In 1950, Phoenix did not make the list of top 20 largest U.S. cities. By 1970, Phoenix was number 20. By 1980, Phoenix was number 9 (U.S. Department of Commerce, 2012). Today Phoenix area is the sixth largest metropolitan area in the United States and is still growing (U.S. Department of Commerce, 2012). Tempe is just a small part of the sprawling 17 thousand square-mile region known as Greater Phoenix (Bruegmann, 2006). The area's sprawling urban form helps to explain why the majority of trips in Tempe are made in cars (See Figure 4.1).

Figure 4.1: Phoenix Metropolitan Region



The Greater Phoenix area encompasses many other cities including Tempe. Note that this sprawling area is covered with an extensive freeway infrastructure because of the long distances that need to be travelled for various trips.
Source: Google Maps

Groningen

The city of Groningen was first mentioned in a document in the year 1040, but it probably existed even before that (Kooij & Pellenburg, 1994). During the 13th century Groningen was a walled city. All residential and economic activity occurred within the borders of the walls thus providing Groningen with an early dense urban form (Van Steen, 2004). There was little need for the city to expand during that time, because it grew very slowly, so activity stayed within the walls for many years. Between 1600 and 1800, the population of Groningen grew from only 19 thousand to 23 thousand (Kooji & Pellenburg, 1994). Consequently the early years of Groningen had significant influence on its current urban form. Although World War II left much of the city in shambles, Groningen has subsequently maintained a dense urban form.

A New Start After World War II

The most significant influences on the urban form in the city of Groningen occurred subsequent to World War II. Like many cities throughout Europe, Groningen was in shambles after the war and had to be rebuilt. From April 13 to 16, 1945, the Battle of Groningen resulted in hundreds of deaths and almost 300 destroyed buildings (Dykstra, 2002). Despite being a major setback for European cities, the war provided public planners with the opportunity to exercise a great deal of new authority, and influence future growth (Bruegmann, 2006). Much of the postwar planning effort was geared towards the reconstruction of the destroyed cities by rebuilding industries and managing the fast-growing population. The planning was comprehensive and on a national scale. In fact the facilitation of growth and associated planning was mostly

unquestioned after the war so there was little need for societal cooperation (Gerrits, et al. 2012).

In 1941 the Government Agency for the National Plan was established in the Netherlands. In 1950 the agency published the National Plan, which outlined detailed plans for cities throughout the country. However, this document was too detailed and thus too complicated (Van Steen, 2014) so planners eventually disregarded it. Ten years later the First Memorandum on spatial planning in the Netherlands was published. This memorandum was concerned mainly with building new houses and the development of industries, which were seen as top priorities after five years of war (Pellenbarg & Van Steen, 2002). In 1966 a Second Memorandum was established. This was the first powerful stand against suburban sprawl through efficient land use and funding of services and infrastructure. This document was concerned with efficient land use (land was considered as an irreplaceable asset) and funding of services and infrastructure to preserve the Green Heart. The Green Heart is a preserved, open green space surrounded by the major Dutch cities of Rotterdam, The Hague, Leiden, Haarlem, Amsterdam and Utrecht (Geurs & van Wee, 2006). However, by this point, the Dutch government projected that the country's population would grow from 12.4 million in 1966 to 20 million in 2000 (Tsubohara, 2010). As a result, the Second Memorandum aimed at addressing the future population spike of the Netherlands through 'concentrated deconcentration' (Geurs & van Wee, 2006). The idea was to accommodate growth outside existing urban areas in designated overspill centers. It was seen as a feasible compromise between concentration and low-density dispersal (Geurs & van Wee, 2006). Furthermore, the memorandum advocated a spatial policy of spreading population and

economic activities more evenly across the country. More specifically, it allocated a population of 3 million to the northern three provinces and between 250 thousand and 500 thousand to Groningen, which back then had a population of only 160 thousand (Tsubohara, 2010). In response, the municipality of Groningen published the Structure Plan Groningen of 1969, which called for building 40 thousand new houses. Nonetheless the projected population spike was not nearly as large as previously predicted.

A Shift in Ideas

The policies enacted by the national government subsequent to World War II proved to be very successful at fostering economic and physical growth throughout the Netherlands. However, many of the plans at this time were modernist with an expectation of growth, an emphasis on efficiency and a belief in technology (Tsubohara, 2010). While this thinking was prevalent in the urban planning field, politics in Groningen shifted and as a result so did the future of the city. During the 1960s and early 1970s Vismarkt and Grote Markt were dominated by 120 parking spaces, a bus terminal and traffic lanes. As a result these areas were congested, polluted and unhealthy. A new political party saw this as a problem and published the Objectives Document. The idea was to propose a plan to restrain car use in the public squares and give priority to public transportation, bicycles and pedestrians (Tsubohara, 2010). Despite support for these ideas in planning circles, there were many who opposed them. Many businesses in the inner city claimed that shutting down the area to cars would deter customers and would thus be detrimental to business. The Chamber of Commerce claimed that removing cars from the city center would result in it becoming an “abandoned area” (Tsubohara, 2010, p. 69). The idea of achieving a car-free city center or at least reducing the amount of cars

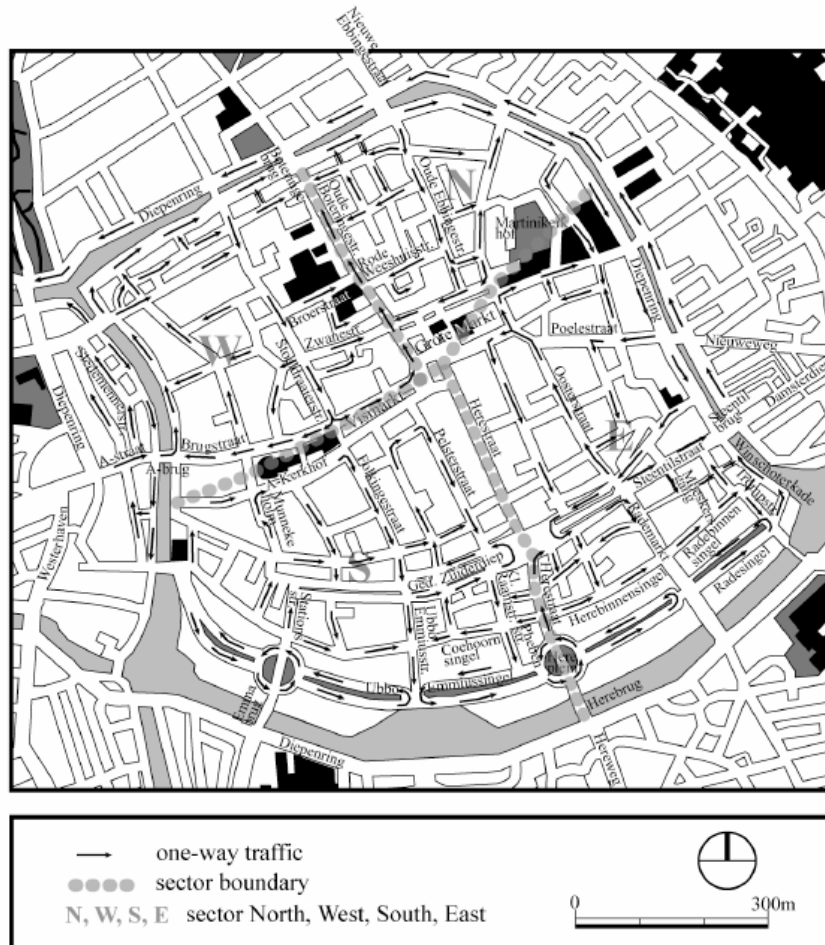
was not popular in the public eye. Furthermore, the municipality of Groningen at the time was operating public transit from its own budget and was facing significant deficits. Creating a car free city center was not only unpopular but it was also too expensive (Tsubohara, 2010).

Creation of the Traffic Circulation Plan

In 1973 a letter from Minister Westerterp of Central Ministry of Transport and Public Works claimed that if the city of Groningen could make a Traffic Circulation Plan (VCP) and submit it no later than January 1, 1975, the central government would take over the city's deficits. As a result, the idea of reducing cars in the city center came back to fruition (Tsubohara, 2010). A wave of unrest and anxiety flooded the business community in the inner city. A new business plan was updated behind closed doors so that there was no opportunity for public participation. This plan divided the city into four sectors by introducing one-way traffic restrictions. A car could not drive directly from one quadrant to another. They would have to go to the ring road ('Diepenring') surrounding the inner city and take that to the next sector. However, pedestrians and cyclists could go directly from one sector to another. The idea of the plan was to not only dissuade people from driving but also make mobility as efficient as possible for pedestrians and cyclists (Figure 4.2). Even though this plan let cars into the city, businesses still did not like the plan and 400 signatures were gathered from business people to try and stop the VCP. Nonetheless despite public outcry the VCP was still approved. On the night of September 18, 1977 various works were conducted throughout the city including installing new traffic boards, repainting roads and moving curbs. By the next morning the city was divided into four sectors and both business owners and

commuters found that it did not cause the problems they had originally predicted (Tsubohara, 2010). The VCP has been so successful that it is still in use today.

Figure 4.2: Groningen Traffic Circulation Plan



Groningen's Traffic Circulation Plan (VCP) divides the city into four sectors allowing only pedestrians and cyclists to cross between each sector while forcing vehicular traffic onto the surrounding ring road.

A shift in planning ideas was seen at the national level as well. The Fourth Memorandum in 1988 shifted urban planning from the suburbs back to the cities. The idea of ‘concentrated deconcentration’ had led to a decline in economic activity and population in the inner cities. As a result, the Compact Spatial Policy was introduced. The Fourth Memorandum guided the construction on brownfield areas in cities and designated new greenfield locations near existing cities. The plan was seen as a success because the housing stock as well as the number of inhabitants in large cities increased significantly throughout the 1990s (Geurs & van Wee, 2006). The Compact Spatial Policy has further contributed to the success of the Traffic Circulation Plan seen in Groningen because without compact urban development policies, urban sprawl would likely have been greater in Groningen resulting in less compact urbanization patterns and more car use. The fact that the city is dense from the Compact Spatial Policy and that it is generally more convenient and efficient to bicycle from the Traffic Circulation Plan influence the high bicycling rates seen in Groningen today (Geurs & van Wee, 2006).

Traditionally Dutch spatial planning has taken place at the national level with comprehensive plans for every city. However, within the past decade, spatial planning has shifted fundamentally. Area-development and area-specific planning decisions are becoming increasingly important in order to plan for each unique region. In 2006 Parliament approved a major revision of the Law on Spatial Planning that had been in place since 1965. This revision delegated most of the spatial planning in the hands of provinces and even municipalities. The motto of the revision was “local when possible, national if necessary” (Gerrits, et al. 2012, p. 338). As a consequence many provinces

throughout the Netherlands have abolished the Compact Spatial Policy within their respective regions. Nonetheless, the Province of Groningen still has the policy in place.

Was Growth Regulation Really Necessary?

The liberal urbanization scenario reflects land use developments when no restrictive policies are used to prevent future sprawl against urbanization. This scenario has been hypothetically applied to the Netherlands between the years of 1970 and 2000 when there was significant economic and population growth throughout the country. According to the findings, if the scenario were real, the Dutch population would grow by 35 percent in suburban areas, by 25 percent in peripheral areas and by just 5 percent in central urban areas. Based on these findings it is obvious that without urban development policies in the Netherlands, urban sprawl is likely to have been greater, resulting in less compact urbanization and ultimately more car use and less bicycle use (Geurs & van Wee, 2006). The Phoenix/Tempe area is the perfect example of liberal urbanization. The idea was to let the market determine the city's growth and now it is one of the most sprawling cities in the United States.

Conclusion

In conclusion, the urban forms and densities between the cities of Phoenix/Tempe and Groningen are quite different. The Phoenix area sprawls for many miles while Groningen is quite dense. As a result, the majority of people in Phoenix rely on cars as their most common mode of transportation and a large portion of the residents in Groningen rely on bicycles. The history of these two places helps to explain their current urban forms as well as the residents' mobility behaviors. In essence sprawl made Phoenix

popular in the past. Americans from across the country moved to Phoenix in search of a large piece of property away from the center of the city. The lack of planning regulation and the availability of cheap land further justified these actions. Groningen on the other hand experienced much stricter planning regulations by both the central government as well as by the province. The combination of Groningen's Traffic Circulation Plan as well as the national Compact Spatial Policy have molded Groningen into the dense, bicycle friendly city that it is today. The question is: What other policies aside from those that govern urban form can be applied from Groningen to promote bicycling among Millennials in Tempe? Answering this question is covered in the following chapters.

CHAPTER 5

FINDINGS FROM GRONINGEN

Introduction

Table 5.1 below shows the results from the 115 surveys I distributed to individuals during my time in Groningen. From the results, it is obvious that the *practical/utilitarian benefits* associated with bicycling in Groningen were the most influential. *Practical/utilitarian benefits* consist of the cost-savings, time-savings and safety advantages that come with bicycling when compared to driving. The high level of influence of the practical/utilitarian benefits is unsurprising given Groningen's strong "carrot" and "stick" policies to promote bicycling as well as minimize driving. The "carrot" policies affect Groningen's urban form by fostering an appealing bicycle environment. The "stick" policies affect the economy by suppressing the appeal of driving through monetary means. The combination of these two policies explains Groningen's bicycling success. Overall, the *supplemental consequences* of bicycling did not generate a noteworthy influence for travelers. *Supplemental consequences* consist of the personal feelings and physical exercise associated with bicycling.

The Level of Influence of The 11 Factors

Table 5.1: Survey Results

Theme	Category	Factor	Little to no influence	Neutral	High influence
Practical/ utilitarian benefits	Economy ("Stick")	Cost of owning a car	16%	13%	71%
	Urban form ("Carrot")	Time	16%	17%	67%
		Safe bicycle infrastructure	16%	20%	64%
		Distance	21%	21%	58%
		Bicycle parking	37%	20%	43%
		Coordination between public transportation and bicycle transportation	63%	11%	26%
Supplemental consequences	Comfort	Weather	37%	24%	39%
		Relaxing	43%	19%	38%
		Possibility of Bicycle theft	50%	27%	23%
	Health	"Being green" (Sustainable)	44%	21%	35%
		Exercise	36%	35%	29%

Source: Author

Practical/utilitarian benefits

Economy (“Stick” Policy)

The *cost of owning a car* seemed to have the most significant impact among the personal factors contributing to bicycling. Only 16 percent of the respondents claimed that the cost of owning a car had little to no influence on their commuting decision. Over 70 percent said that this factor had a significant influence on their commuting behavior.

It is understandable why the cost of owning a car would be such an influential factor, particularly in the Netherlands. The country is known for imposing high taxes and fees on car purchase, ownership and use (Pucher & Buehler, 2008). For example, the sales tax on a car in the Netherlands is nine times higher than in the United States (O'Sullivan, 2009). The Netherlands has an especially high sales tax on petrol (Pucher & Buehler, 2008). As of March 2015, the price per gallon was \$6.50, significantly higher than the current price of \$2.70 per gallon in the United States (U.S. Energy Information Administration, 2015) Furthermore the influence of the cost of car ownership is especially high in Groningen because of the high population of students. As Professor De Roo explained, “If you’re a student it’s quite expensive to have a car. The price of petrol is way higher than the US and of course cars themselves are more expensive” (Interview, De Roo, 2014). Unlike the various costs associated with purchasing and maintaining a car, owning a bicycle is significantly cheaper. Dr. Tan explained, “Because owning bicycles have become more accessible, they are no longer considered rare or expensive” (Interview, Tan, 2014).

Urban Form (“Carrot” Policy)

Time and distance are strongly correlated, because the distance that needs to be travelled influences the amount of time it takes to travel that distance, so these two factors are grouped together. Overall it was obvious that both of these factors were significantly influential for people. Fifty-eight percent of the respondents said that the distance to be travelled was very influential. Sixty-seven percent of the respondents said that the amount of time it takes to reach the destination was highly influential.

As mentioned above, Groningen’s Compact Spatial Policy combats vehicle use and promotes bicycling as a mode of transportation by minimizing distance from the city center. According to the policy, a distance that is further than 7.5 kilometers is bad because people will start using their cars for transportation instead of bicycling. As a result, most activities are within 7.5 kilometers of the city center (Van Steen, 2014). The key to the Compact Spatial Policy is the promotion of mixed-use development. Unlike sprawl, which promotes segregated, homogeneous land uses, the mixed-use development in Groningen integrates offices, businesses and government buildings in Groningen’s city center. Bicycling is promoted not only by Groningen’s high density and mixed-use development, but also by the design of its road network. As earlier described, Groningen’s Traffic Circulation Plan limits car use in the inner city by directing traffic to the outer ring road, often making bicycling a more efficient mode of transportation than the car. As can be seen in Table 5.2, had the respondents decided to drive, 56 percent would have lost time or saved no time in the process. Figure 5.1 illustrates an example of how bicycling is often more efficient than driving in Groningen.

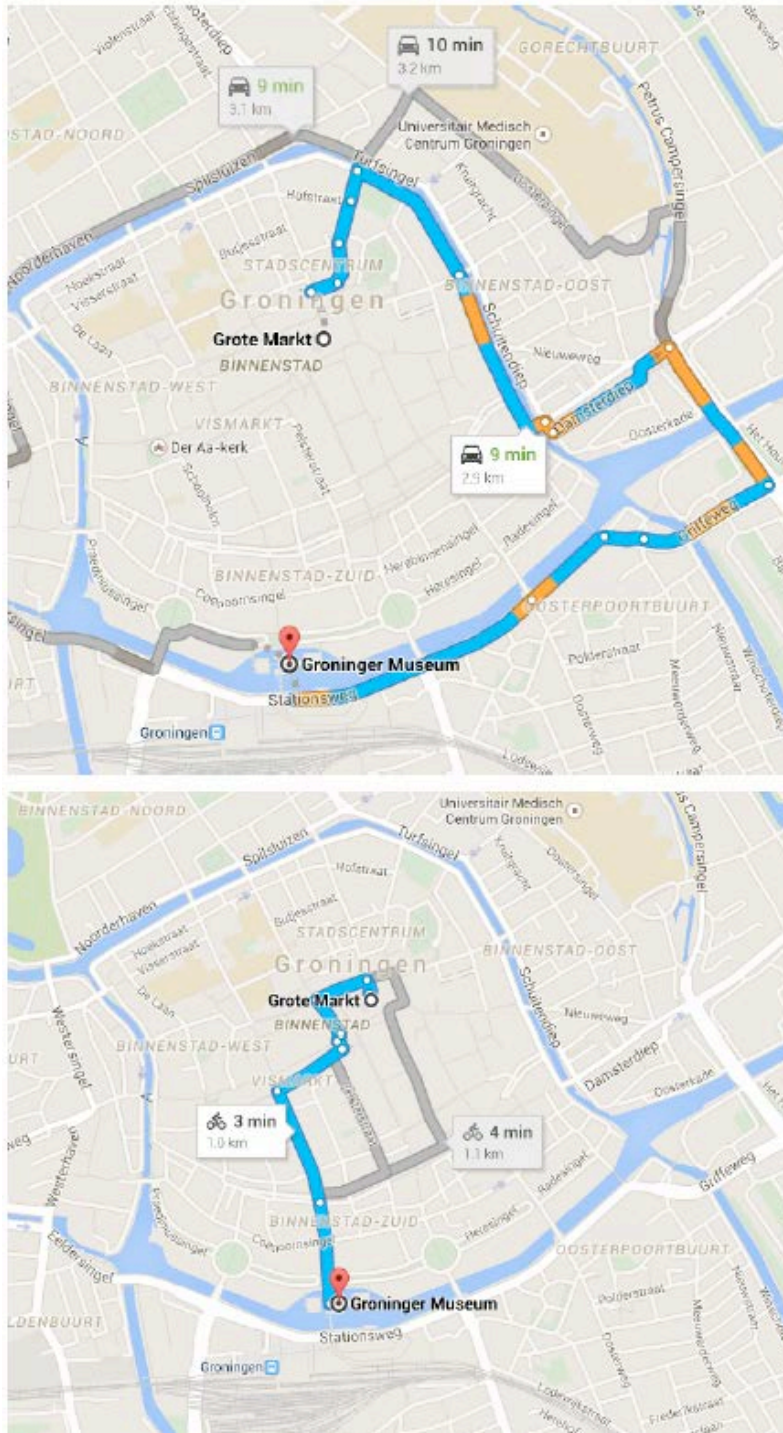
Table 5.2: Time Taken During Trip

If driven, would you have...	
Saved a lot of time?	13%
Saved some time?	31%
Saved no time?	26%
Lost some time?	23%
Lost a lot of time?	7%

Groningen's high density and Traffic Circulation Plan make bicycling a competitive transportation mode with the car

Source: Author

Figure 5.1: Groningen's Traffic Circulation Plan In Action



Thanks to Groningen's Traffic Circulation Plan, in many cases it is actually faster to travel by bicycle than by car. These maps show the distance and time it takes to travel from the Grote Markt to the Groninger Museum using either a car or a bicycle. Making this trip in a car requires driving to the ring road of the city to go from one sector to the other. The car must travel a distance of 2.9 km for 9 minutes. A bicycle can go directly from one sector to the other. As a result, this trip on a bicycle takes only 3 minutes because the bicycle has to travel only 1 kilometer. Source: Google Maps

Safety was a highly influential component of urban form. Sixty-four percent of the respondents said that a safe bicycle infrastructure had a significant influence on their commuting decision. “One important reason for the universality of cycling [in the Netherlands] is the relative safety of cycling compared to other countries” (Pucher & Buehler, 2007). Groningen has invested heavily in its bicycle infrastructure to increase bicycle safety. For example, as shown in Image 5.1, the bicycle lanes in Groningen are wide with physical barriers separating traffic. The Netherlands has drastically reduced the amount of fatal car accidents with bicyclists because of these bicycle infrastructure improvements. In 1980, 426 cyclists died in the Netherlands. That number was drastically reduced over the years; in 2005 only 181 cyclists died (Frulanu, et al, 2009). Between 2002 and 2005, the Netherlands had the lowest cyclist fatality rate in the world at just 1.1 bicyclist fatalities per 100 million km cycled. However, the bicycle fatality rate in the United States within the same time frame was 5.8 per 100 million km cycled (almost five times higher than the Netherlands) (Pucher & Buehler, 2007).

Image 5.1: Bicycle Path Separation



**Many of the bicycle paths in Groningen are completely separated from traffic.
Source: Author**

Bicycle parking had a medium level of influence on bicycling. Forty-three percent of respondents said that the availability of bicycle parking had a strong influence on their commuting decision. However, 37 percent claimed that bicycle parking had an insignificant influence on their commuting decision. In the middle, 20 percent claimed that it had some influence but was not too significant. It therefore appears that respondents were more or less cut down the middle when it came to the level of influence

of bicycle parking. Perhaps Image 5.2 best illustrates this outcome. As can be seen in the photo, many people used the bicycle racks provided on the sidewalk. However, as soon as these were full people simply adapted and parked their bicycles without a bicycle rack. Therefore, it is logical to conclude that while people probably prefer to secure their bicycle to a bike rack, if there is not one available they will simply find an alternative parking spot.

Image 5.2: Bicycle Parking



A lack of available bicycle parking racks means bicyclists adapt and find parking elsewhere. Here bikers found satisfactory parking space on the sidewalk.

Source: Author

Coordination between public transportation and bicycle transportation was noted as the least influential component of urban form. Sixty-three percent of respondents said that coordination between public transportation and bicycle transportation was unimportant for them. This was unsurprising given that the

majority of those surveyed solely rode a bike without supplementing the trip in a train or bus. Perhaps Groningen's Compact Spatial Policy influenced this trend. As discussed above, Groningen is an extremely dense city thanks to its Compact Spatial Policy. Getting from one place to another does not require a long distance to be travelled and is therefore very manageable on a bicycle without the help of a bus or train. Furthermore, many of the residents live close to the city center. In 2005, 78 percent of Groningen's residents and 90 percent of its jobs were located within a 3-km radius of the city center. This compactness fosters trips that are short enough to be made on bike (Pucher, & Buehler, 2007). According to Dr. Tan, "Most Dutch towns are pretty compact so the distance is much less than if you're talking about a North American city" (Interview, Tan, 2014). Nonetheless, it is worth noting that, 26 percent of respondents said that coordination between public transportation and bicycle transportation was either somewhat important or very important for them. A possible explanation for this is that these individuals like to have the option of being able to supplement their trip with the help of a train or bus. After all, when it comes to transportation choices, Millennials prefer to have more than one option (Dutzik, & Baxandall, 2013).

Supplemental Consequences

Comfort

Weather was only slightly influential for bicyclists. 37 percent of respondents said that the weather had an insignificant influence on their commuting behavior. Another 24 percent claimed that they felt neutral about the influences of weather. According to the

interview with Mr. Vissers, Dutch culture explains this trend. “Some people can’t believe we [the Dutch] still cycle when it is raining or when there is snow. Last year I was in Vienna and the guy there said, ‘It’s impossible to use the bicycle when it’s snowing,’ and I said, ‘No it isn’t, I can show you pictures’” (Interview, Vissers, 2014). Nonetheless, there was a surprisingly large amount of respondents (39 percent) who said that the weather had a significant influence on their commuting decision to bicycle. In other words, if the weather were unpleasant, these individuals would use an alternative mode of transportation besides the bicycle. Perhaps this can be related back to the results from those who claimed they were highly influenced by *coordination between public transportation and bicycle transportation* (above).

Relaxation received mixed levels of influence from respondents. Thirty-eight percent said that relaxation was highly influential for bicycling. This was unsurprising given that past studies have found that the vast majority of Dutch citizens enjoy bicycling. For example, one study found that almost 70 percent of Dutch citizens associate bicycling with joy while around only 2 percent associate bicycling with sadness (Pucher & Buehler, 2007). Nonetheless, 43 percent of survey respondents claimed that relaxing had little to no influence on their behavior. This is also unsurprising given that bicycling in the Netherlands is primarily seen as a practical, utilitarian purpose. For example, travel to work or school accounts for 32 percent of bike trips in the Netherlands. Another 22 percent of bicycle trips are used for shopping. Only about a fourth of bicycle trips in the Netherlands are for purely recreational purposes (Pucher & Buehler, 2007). It is therefore logical to conclude that the Dutch use bicycling for practical transportation purposes but are able to relax as a supplemental consequence.

Possibility of bicycle theft had a negligible influence on commuting behavior. Over 50 percent of respondents claimed that the possibility of bicycle theft had little to no influence on their behavior. Only 23 percent said that this factor was highly influential on their decision to bicycle. It is safe to conclude that the influence of the potential of bicycle theft is insignificant among the general population. These results are consistent with the results from the availability of bicycle parking. As mentioned above, people prefer to have bicycle parking but if it is not available, they will simply park their bicycle elsewhere. Doing so most likely increases the chances of bicycle theft, which as shown in the chart above is an insignificant influence. Of course, nobody wants to have a bicycle stolen but these results reveal that the risk of bicycle theft would not dissuade individuals from bicycling.

Health

Being “green” was not influential. Forty-four percent of respondents said that the influence of riding a bicycle simply to be more sustainable was an insignificant factor. Another 21 percent said they felt neutral about this influence. While it is safe to assume that many of the Dutch are concerned about global sustainability issues and climate change, it is obvious that most people bicycle for other reasons other than reducing their carbon footprint.

Exercise yielded similar results to *being “green.”* Thirty-six percent of respondents said that exercise was not influential for them to bicycle. Another 35 percent said they felt neutral about the influence of exercise. It is safe to assume Dutch appreciate the various health benefits associated with bicycling; however, this survey result supports that exercise alone is not sufficiently influential to get people bicycling as a legitimate

mode of transportation. As stated above, most Dutch people see bicycling as a practical, utilitarian purpose. In fact, only about one fourth of all bicycle trips in the Netherlands are for purely recreational or exercise purposes (Pucher & Buehler, 2007).

Conclusion

As portrayed in the survey results, the fundamental reason Millennials in Groningen bicycle is because it is the most utilitarian and practical mode of transportation for the city. It is regarded as the most practical mode of transportation because the municipality of Groningen and the National Dutch government have imposed both “carrot” and “stick” policies to promote bicycling and suppress driving. It is important to note that the high rate of bicycling seen not just in Groningen but throughout the Netherlands would be impossible to achieve without both types of policies in place.

The level of influence of the supplemental consequences from bicycling was negligible. This makes sense, because the majority of these consequences are universal and yet most countries do not have bicycle rates close to that of the Netherlands. For example, global warming is considered a global crisis largely caused by the emissions from automobiles. Yet most Americans have not suddenly decided to ditch their vehicles for a bicycle to be more sustainable. For that to happen, the United States would have to impose “carrot” and “stick” policies to make bicycling a practical mode of transportation just like in the Netherlands. The next section discusses how that can be achieved in Tempe.

CHAPTER 6

APPLYING RESULTS TO TEMPE

Introduction

The last section concludes that high bicycling rates can only be achieved if it is perceived as a practical mode of transportation. Imposing “carrot” and “stick” policies in a city impacts its economy and urban form and can thus increase the practicality of bicycling. Unfortunately Tempe’s economy and urban form have not been adequately impacted by “carrot” or “stick” policies aimed at increasing bicycling. But rather the “carrot” policies impacting Tempe’s urban form have traditionally promoted driving instead while “stick” policies have been virtually nonexistent. If Tempe expects to increase bicycling to a meaningful level, a fundamental shift in the “carrot” and “stick” policies must occur so that bicycling can become a practical mode of transportation. This section discusses how that can be achieved.

“Carrot” Policies

Increase the Efficiency of Bicycling

The biggest limitation to increasing bicycle ridership in Tempe is the city’s urban form. Unlike Groningen, which incorporates a compact spatial structure, Tempe’s size of 40 square miles (U.S. Department of Commerce) is large enough to discourage even the most avid bicyclists. It’s not only the size that is the problem but also Tempe’s land use and zoning. Again, in contrast with Groningen, which is comprised of mixed-use buildings, Tempe’s form consists almost entirely of segregated land uses, further inhibiting motivations to bicycle. These land uses consist of four components, all of

which occur independently and are strictly segregated from one another (Duany, et al, 2000).

1. *Housing subdivisions* consist of only residences (Duany, et al. 2000). The lack of mixed-use development in this neighborhood type means the nearest business is miles away and not conducive to riding a bicycle to work or the grocery store.
2. *Shopping centers* also known as shopping malls or big-box retailers are places exclusively for shopping. A typical shopping center is easy to identify in Tempe and the greater Phoenix region because of its massive parking lot, single-story height and absence of housing or offices (Duany, et al. 2000). Tempe Market Place is a classic example of a big-box shopping center as shown in Image 6.1. The land use of this shopping center caters to the automobile with little regard to pedestrians or bicyclists—the majority of the space is a parking lot. Furthermore, like most shopping centers, Tempe Marketplace is located off a major freeway and accessible by large arterial roads allowing shoppers from surrounding regions to quickly visit this location by car while making it dangerous to arrive by bike.

Image 6.1: Typical Tempe Shopping Center



The majority of the land at Tempe Marketplace consists of a parking lot rendering it unattractive as a bicycling destination.

Source: Author

3. *Office parks* and business parks are places only for work. They typically contain a large parking lot in front and are in close proximity to a freeway or major arterial road. (Duany, et al. 2000).
4. *Roadways* are the fourth component of sprawl. They are necessary to connect the three other dissociated components of a city. Each component of suburbia serves only one function, and all the components are isolated from each other. This means that Tempe residents spend significant time and money driving large distances from one place to another. The only way to sustain large traffic volumes over long distances is through Urban Principle Arterial Roads. Tempe defines Urban Principal Arterial Roads as those allowing traffic movements in urban areas consisting of through movements and major circulation movements. Many of the roads in Tempe are classified as Urban Principle Arterial roads, meaning they are very wide, allowing for fast moving traffic, resulting in unsafe conditions for bicyclists and pedestrians. Image 6.2 shows a typical Urban Principle Arterial Road connecting to Tempe Marketplace (shown below).

Image 6.2: Entrance to Tempe Marketplace



The entrance in front of Tempe Market Place is along a principal arterial road consisting of seven lanes of traffic. This street was designed exclusively for cars with little regard for bicyclists and pedestrians.

Source: Author

In summary, sprawl means long distances to reach a destination so unsurprisingly there is a strong correlation between a sprawling city and reliance on vehicles (Kanafani, 2009). According to Dr. Koster, “I haven’t been to Phoenix but I’ve been to places like it. I mean the sprawl is immense. If you want to go somewhere like from where you live to a work place the distances are just so much bigger than they are here. So for me that would be probably the single most important physical feature of cities to promote cycling” (Interview, Koster, 2014). If there is any hope of raising bicycling rates in Tempe, a

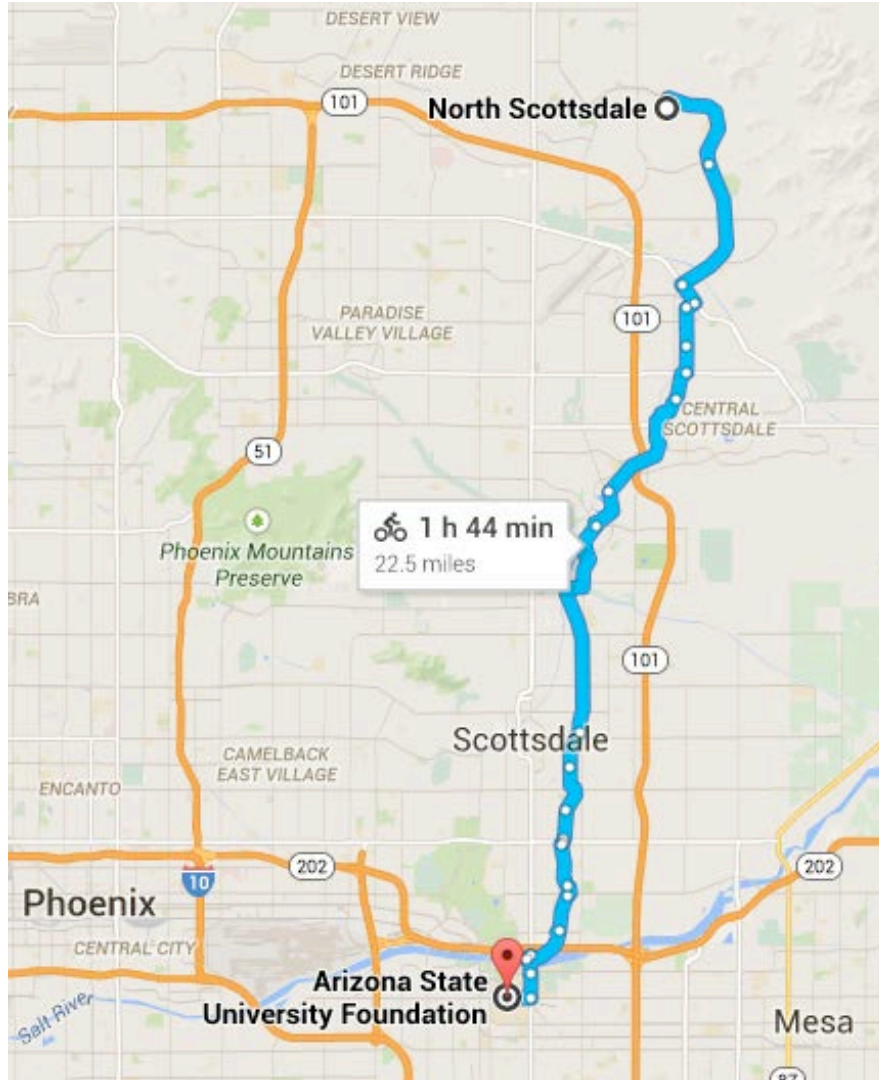
fundamental shift in the city's current land use policy must occur in order to increase the efficiency of bicycling. This can be achieved in the following ways:

Increase the density and mixed-use development of the city: Fortunately this has already started. As mentioned in the introduction, Millennials are increasingly moving back into city centers. The housing and construction market in Tempe are proof of this trend. Throughout Tempe's downtown, new construction projects of mixed-use buildings containing apartments, restaurants and offices are underway. It is logical to believe this trend will continue well into the future as more Millennials will continue moving away from the suburbs (Gallagher, 2013). What does this mean for the future of bicycling? It means that as Tempe grows denser and reduces the amount of segregated land use, bicycling trips will be shorter and faster thus rendering it as a more practical mode of transportation.

Improve the efficiency of public transportation and its integration with bicycles: Although the survey results portray that the integration of bicycle infrastructure and public transportation are not highly influential in Groningen, it is important to note that Groningen's design retains most activities within 7.5 kilometers of the city center (Van Steen, 2014). As mentioned above, when destinations exceed the distance of 7.5 kilometers from one another, individuals who normally bicycle will begin to search for alternative modes of transportation (Van Steen, 2014). It is logical to conclude that the importance of the integration between bicycle infrastructure and public transportation was diminished because of Groningen's unique compact urban form. This factor is probably more influential in Tempe because the city encompasses significantly more geographical area than Groningen. Despite Tempe's growing density and increased

mixed-use developments, the municipality incorporates a landmass of 40 square miles thus posing a challenge for bicycle promotion because of the large distances between destinations. These distances are even more extreme when considering Tempe in the context of the greater Phoenix region, which consists of 516 square miles (U.S. Department of Commerce, 2015). For instance, as can be seen in Figure 6.1, it is inconceivable for the average commuter living in North Scottsdale to bicycle the entire distance to downtown Tempe. According to transportation planner Eric Iverson, “If you have better transit and more transit, that helps augment your bicycle ridership numbers, because a lot of people will ride to the light rail to get to wherever” (Interview Mr. Iverson, 2014). Therefore, if Tempe expects to raise bicycling to meaningful levels, the surrounding municipalities must become involved as well in order to make the necessary investments in public transportation.

Figure 6.1: Distance Between Scottsdale and Tempe



The distance between many locations in Phoenix is too far to even consider bicycling
Source: Google Maps

Fortunately several bicycle integration features are already implemented on existing public transportation in Tempe and the surrounding municipalities. These features include the following:

- A. Bicycle racks on buses- the buses traveling throughout the Phoenix region are equipped with front bicycle racks. One study found that bicycle racks on buses had a positive impact, generating more revenues than the cost of installing racks (Pucher, Dill & Handy, 2010). This is a vital component for bicyclists commuting long distances as it allows them to supplement the bicycle ride on a bus. The bicycle racks make it possible for a commuter to bicycle to the nearest bus stop and load his bicycle on a bus, which would then drive the majority of the distance towards his destination. Once the bus is within a reasonable distance from the final destination, the commuter would then bicycle the rest of the distance.
- B. Bikes on rail cars- the bicycle racks available on the Valley's light rail line are also important for the same reason as bicycle racks on buses.
- C. Bicycle parking at bus stops and rail stops- unfortunately the light rail and buses have limited bicycle rack space. Thankfully several bus stops and light rail stations around Tempe provide bicycle parking in case these modes of transport reach full bicycle storage capacity.

Despite the existing components of bicycle integration on the Valley's buses and light rail, these systems still fall short in rendering bicycling as a practical mode of transportation in the region. Significant room for improvement exists regarding the quality of public transportation. The most important recommendations include the following:

A. Increase the frequency of buses and light rail at each stop- according to one study; a 10-minute wait for either a bus or light rail was about the maximum that was tolerable for many people (Tyler, 2002). In other words, bus and light rail stations should be served six times an hour. However, as shown in Table 6.1, the bus frequency travelling along a major corridor in Tempe is only twice an hour (Valley Metro, 2015).

Table 6.1: Timetable of Valley Metro Buses

STOP #12031 South Mountain Community College	STOP #12040 32nd St & Broadway	STOP #12051 University & 52nd St	STOP #12059 University & Mill	STOP #12067 University & Mcclintock
-	-	04:54 AM	05:02 AM	05:11 AM
-	-	05:24 AM	05:32 AM	05:41 AM
05:29 AM	05:40 AM	05:48 AM	05:56 AM	06:05 AM
05:54 AM	06:07 AM	06:17 AM	06:25 AM	06:35 AM
06:24 AM	06:37 AM	06:47 AM	06:55 AM	07:05 AM
06:54 AM	07:07 AM	07:17 AM	07:25 AM	07:35 AM
07:24 AM	07:37 AM	07:47 AM	07:55 AM	08:05 AM
07:54 AM	08:07 AM	08:17 AM	08:25 AM	08:35 AM
08:26 AM	08:39 AM	08:49 AM	08:57 AM	09:07 AM

To optimize the practicality of using public transportation buses should come six times an hour. In the case of Tempe and the surrounding valley, most stations are serviced just twice an hour

Source: Valley Metro

- B. Implement a valley-wide bus rapid transit (BRT) network- BRT is a high capacity, high performance bus-based system. BRT systems typically have designated lanes, providing physical separation from mixed traffic and thus insulating the network from traffic congestion. Creating designated bus lanes is especially feasible in the Phoenix area given because of the unnecessary wide width of many arterial roads. BRT is arguably a better value for the money than a light rail (LRT) system. In many cities, \$200 million spent on a bus system would produce more improvement in accessibility than the same amount on a single LRT line because it would cover a larger area and serve more people (Hensher, 1999). Furthermore, the savings associated with the systems installation and maintenance could go towards providing service to stations six times an hour as recommended above.
- C. Improve bus stop conditions- Many of the bus stops around the Valley provide unsatisfactory conditions for travelers. Many provide no place to sit and offer no shade, which is especially important during the summer months. Improving these areas would increase the level of comfort associated with using the bus.

Although high quality public transportations systems are expensive to maintain, it is worth noting that cities can expect to attract new companies who are searching to locate next to these types of accommodations. For example, State Farm Insurance is currently building a \$600 million hub in Tempe and said it strategically located in Tempe because “access to public transportation and multiple transportation options is critical to our operations going forward” (Leavitt, 2015). Nonetheless, making large investments in

public transportation is only feasible if density around bus stops or transit stations is high enough to attract a sufficient amount of riders (O'Sullivan, 2009). With this in mind, as the density continues to increase in Tempe, demand for public transportation will grow, generating more revenue to improve the system which in turn will increase bicycling. According to Eric Iverson, "Making sure that transit is accessible and convenient for as many people as possible will help fuel the rise in the number of people riding bikes" (Interview, Mr. Iverson 2015). However, these changes will provide negligible improvements for bicycling unless bicyclists feel safe on the road. Improving bicycle safety in Tempe is discussed next.

Improve Bicycle Safety

As discussed above, the Urban Principal Arterial Roads located throughout Tempe are designed solely with the idea of moving vehicle traffic as quickly and efficiently as possible with little regard for pedestrians or bicyclists. The traffic movements on these corridors involve speed limits up to 45 miles per hour (Department of Transportation, 2011). A consequence of this means dangerous conditions for those who decide to commute by bicycle. A pedestrian hit by a car travelling 30 miles per hour is seven to nine times more likely to be killed than by a pedestrian hit by a car travelling 20 miles per hour (Speck, 2014). Image 6.3 shows a typical urban arterial road in Tempe. This one happens to be located across the Street from Arizona State University where many students walk or ride their bicycles to campus and are often exposed to the dangers of the fast moving traffic on this seven-lane road. Notice that the road does not even have a bicycle lane on either side. Many of the bicycle lanes that do exist in Tempe are noticeably narrower than those in Groningen and have no level of separation from traffic

besides a line painted in the pavement (Image 6.4). This is particularly alarming given that many of Tempe's bicycle lanes are located on Principle Arterial Roads, which as mentioned above foster fast moving traffic above 45 miles per hour. According to one study, striped bicycle lanes may not increase bicycling when they are located in otherwise poor environments for bicycling (Dill, et al. 2014).

Image 6.3: Tempe Principle Arterial Street



**This busy principal arterial street provides no bicycle lanes. As a result bicyclists are forced to mix with pedestrians on the sidewalk. This is a problem particularly at this intersection as the streetlight takes over half of the sidewalk
Source: Author**

Image 6.4: Bicycle Lane Along Principle Arterial Street



**The narrow lane available for bicyclists along this corridor provides little protection from the seven lanes of traffic moving at a speed limit of 45 miles per hour
Photo by author**

A road diet is a simple, inexpensive yet highly effective bicycle infrastructure improvement that can be made in Tempe to increase the practicality of bicycling in two ways. First, a road diet entails removing travel lanes from a roadway utilizing the space for other uses and travel modes. Second, a road diet can also include lowering the speed limit for vehicles. Reduced speed limits increases bicycling safety in two ways. First, it increases the speed of bicycling relative to the speed of driving thus reducing the chance of an accident (Pucher, et al, 2010). Second, if an accident were to occur, the chance of serious injury or death is reduced because as mentioned above, a pedestrian hit by a car

travelling 48 kilometers an hour is seven to nine times more likely to be killed than by a pedestrian hit by a car travelling 32 kilometers an hour (Speck, 2014). A road diet can be as simple as resurfacing the street to change the amount of lanes and adding a bicycle lane. According to the interview with Professor Golub, “(Cities) need to stripe streets anyway, so it’s almost free, so most cities do [road diets] wherever they can” (Golub, Interview 2015).

Converting a four-lane road to three lanes provides space for a bicycle lane, in each direction. The space provided improves the level of safety for bicyclists, thus contributing to the practicality of bicycling along that corridor. Providing bicycle lanes is essential to increasing the practicality of bicycling. According to a recent study, each additional mile of bike lane per square mile in a city was associated with an increase of approximately one percentage point in the share of workers regularly commuting by bicycle (Pucher, et al, 2010). Furthermore, the study found that people living within a half-mile of a bicycle lane were at least 20 percent more likely to bicycle at least once a week compared to those living between one-half and one mile away from the path (Pucher, et al, 2010).

The practicality of bicycling in Tempe can be significantly increased through changes to the city’s urban form. As discussed above, Tempe’s growing urban density is key to bicycle promotion as it will drastically reduce bicycle travel distance for many trips. Improving the quality of the city’s public transportation and creating a safe bicycling environment are also necessary for the future of bicycling in Tempe. The implementation of these changes will provide the “carrots” to increase bicycling. However, these changes alone do not provide enough influence to make bicycling the

most practical form of transportation in Tempe. Therefore a “stick” approach aimed at reducing driving is also necessary to raise bicycling rates to a satisfactory level. According to Dr. Niekerk, “When in the U.S. they try to stimulate cycling, most of the time it’s investing in cycling infrastructure (“carrot”) but it’s not about discouraging car use (“stick”). I think you should do both to get an effective strategy of cycling promotion” (Interview Dr. Niekerk, 2014).

“Stick” Policy: Increase the Cost of Driving

According to the survey, the most influential factor for bicyclists was the savings associated with bicycling and not owning a car. Therefore without car restrictive ‘stick’ policies, cycling will remain a marginal mode in North America, limiting bicycling to only the most avid enthusiasts and for recreational activities but not for practical transport (Pucher & Buehler, 2006). The most important car-restrictive measures are the following:

Increase the cost of driving- gasoline costs three times as much in the Europe than in the US simply because of higher gas taxes (Pucher & Buehler, 2006). The federal fuel tax of 18.4 cents per gallon has not been raised in since 1993 (Berman, 2014). The Arizona tax is 18 cents per gallon, below the national average of 21.5 cents. The combined federal and state average of 39.5 cents per gallon (Kuby, 2009) brings the total cost of gas in the United States to an average rate of \$2.85 per gallon, much lower than the price of \$6.50 per gallon in Netherlands (U.S. Energy Information Administration, 2015). Sales tax on cars is also significantly more expensive. The sales tax on a car in the Netherlands is nine times higher than in the United States. A higher tax on driving in the US would reduce the practicality of driving and increase the viability of bicycling

(O'Sullivan, 2009). Furthermore the additional tax revenue would provide more funding to improve public transportation, which as mentioned above is important to increase bicycling in the Phoenix region.

Charge for parking- a recent study found that implementing 'carrot' policies by promoting alternative modes of transportation such as high quality public transportation, bicycle infrastructure and even showers were futile when free car parking was included as a benefit (Pucher & Buehler, 2006). Conversely, a study conducted in the city of Ottawa, Canada found that increasing parking rates for government employees from zero to 70 percent of the commercial rate resulted in the number of individuals driving to work decreasing by 23 percent and bus ridership increasing by 16 percent (O'Sullivan, 2009). Therefore benefits for public transportation and cycling seem to work best when car parking is not free. There is plenty of opportunity to charge for parking throughout Tempe and the greater Phoenix region, as free parking is currently abundant. Image 6.5 is a prime example of the plethora of parking at shopping centers. To increase the practicality of bicycling, parking cannot be free. Fortunately installing an extensive infrastructure to charge for parking is not necessary. Placing pay-to-park machines throughout parking lots in Tempe is a cost effective way to accomplish this task.

Image 6.5: Tempe Shopping Center Parking Lot



The free parking offered at most businesses and shopping centers in Tempe provides a major incentive to drive
Source: Author

Political Feasibility

A key difference between planning in the United States and the Netherlands is the role of public participation in the process. Unlike the United States, several planning decisions in the Netherlands have not adhered to public participation. For example, many business owners and citizens in Groningen rejected the proposed Traffic Circulation Plan in the 1970s and yet the municipality decided to implement it anyway. It was therefore by no means a product of public participation (Tsubohara, 2010). This type of scenario is inconceivable in the United States where public opinion and the democratic process have significantly more influence on planning policy. As a result, implementing the proposed changes in Tempe to make bicycling a more practical mode of transportation is fundamentally different than in Groningen.

According to Mr. Iwerson, there are four actors and stakeholders in Tempe who must come to a consensus over each decision. The first actor is the community, which may consist of a neighborhood or a local advocacy group (Interview Iwerson, 2015). One prominent group in Tempe is the Tempe Bicycle Action Group. It is a nonprofit organization, which works to make bicycling a prominent, safe and convenient form of transportation and recreation in Tempe ("Tempe bicycle action Group," 2015). Individuals from the community can promote their agenda by attending public meetings and proposing opposing planning ideas. The second group is the urban planning staff for the city. These individuals have more technical expertise on what changes need to occur in the city and what may be feasibly accomplished through the planning budget. The third group is the transportation commission, which is a group of selected citizens who advise on transportation decisions and also propose their own agenda. The fourth group is the city council, which votes on the decisions promoted by the other groups. The eclectic mix of different actors participating in planning decisions means that it may be difficult and time consuming to enact change in Tempe. However, many Americans see this as an important process in order to garner discussion and gain consensus among various stakeholders in the community. According to Dr. Larson, in the past, several Arizona cities took a different approach to planning decisions by first deciding on a decision, announcing it and then defending it (DAD approach) (Interview, Dr. Larson, 2015). This approach was contentious and enraged many citizens so it has subsequently been dropped.

Thankfully gaining consensus among the four groups towards bicycle promotion (“carrot”) policies has gained momentum and has become easier in recent years for

several reasons. First, looking back to the mid to late 1990s, according to Mr. Iwerson, traffic volume on the arterial roads in Tempe was at an all-time high. However the completion of the valley freeways including the 101, 202 and the widening of the US 60 and Interstate 10 shifted traffic onto the freeways and off of Tempe's arterial roads. Since that time, traffic on many arterial roads in Tempe has diminished thus fostering more consensus among the community, planners and council for implementing road diets and installing bicycle lanes (Interview Iwerson, 2015). Second, around the same time, in 1996, Tempe citizens voted for a half-cent sales tax increase for every \$100 spent that would go towards alternative transportation projects. This tax increase means that alternative transportation modes in Tempe are well funded into the foreseeable future because the tax does not have a sunset (Interview Iwerson, 2015). Third, Tempe is regarded as a college town and as discussed earlier, college students tend to ride their bicycles more than average citizens (Interview Iwerson, 2015). Fourth, Tempe is landlocked, creating a growth boundary for the city. Surrounded by Scottsdale to the North, Mesa to the East, Chandler to the South and Phoenix to the West, it is no longer possible for Tempe to grow outward without annexing the land of another city. This growth boundary is good for bicycling because it means that the only direction Tempe can grow is up, thus increasing the city's density and mixed-use development (Interview Iwerson, 2015). Fifth, Tempe and ASU are committed to sustainable and environmental solutions in transportation, which is good news for future bicycling promotion (Interview Iwerson, 2015). Given the combination of the various factors, the future of bicycle promotion ("carrot" policies) in Tempe is bright. Tempe is currently rated at a silver level by the League of American Bicyclists. This organization provides a policy outline and

hands-on assistance to states, communities and universities to promote bicycle-friendly environments and to make bicycling a real transportation and recreation option for all people (League of American Bicyclists, 2013). Bicycle planners are hoping Tempe will soon reach gold or diamond status, which has only been achieved by a handful of U.S. cities (Interview Iwerson, 2015) including Boulder, Colorado and Davis, California (League of American Bicyclists, 2013).

Despite this growing momentum in Tempe, a major hurdle for the future of bicycling is the improvement of public transportation throughout the entire Phoenix area, not just in Tempe. Many individuals who attend ASU or shop or dine out in Tempe reside in the surrounding cities. As shown in Figure 6.1 above, the bicycling distance for many of these people is too far and needs to be supplemented with public transportation. Transportation is a policy that must be treated at the regional level (Duany, et al, 2000) and therefore the proposal for a BRT system should be implemented throughout Maricopa County in order to connect the surrounding municipalities with one another. This task would have to be accomplished through the Maricopa Association of Governments (MAG). MAG consists of a council of governments, which serves the metropolitan Phoenix area ("Maricopa Association of Governments," 2015). Unfortunately because of the diverse needs and agendas of each city within the Phoenix area, it would be difficult for MAG to enact a region-wide BRT network.

As discussed above, “carrot” policies are only half of the equation when it comes to raising the practicality of bicycling in a city. Just as important are the “stick” policies to lower the practicality of driving. There are many ways to implement “stick” policies but the two that are proposed in this paper are the same ones used in the Netherlands.

These include charging for parking and increasing taxes on car purchases and gasoline. Unfortunately promoting these types of policies has proven to be politically difficult in the United States.

While many of the parking spaces around the ASU campus and downtown Tempe are pay-to-park, most of the parking spaces throughout Tempe remain highly subsidized with no plans to increase parking charges in the future (Interview Iwerson, 2015). Getting the community, planners and legislature to agree on increasing the price of parking in Tempe is unlikely. The problem is that Tempe's local economy is competing with other surrounding local economies including Scottsdale, Mesa and Phoenix. Charging more for parking in Tempe may discourage visitors and residents to reside in Tempe and thus push them to the surrounding cities with free parking. Similar to the issue of increasing public transportation, charging for parking is a problem that must be solved at the regional-scale under one jurisdiction so that it applies to all cities in the valley and does not give one municipality an advantage over the others (Duany, et al, 2000). Again, the Maricopa Association of Governments (MAG) would need to get involved. Yet due to the diverse needs and agendas of each city within the Phoenix area, it would be difficult for MAG to enact region-wide legislation on parking. Raising taxes on driving will also be politically difficult. Despite recent debate in Congress regarding this issue, it has gotten nowhere. According to former Republican Congressman Steve LaTourette, "I think it's too toxic and continues to be too toxic. I see no political will to get this done" (Berman, 2014).

CHAPTER 7

DISCUSSION AND CONCLUSION

The driving boom in the United States has ended. Arizona alone has experienced a decline in annual driving miles per capita by 10.5 percent in recent years (Bikes trains & less driving, 2014). As Millennials continue to move away from the suburbs and into city centers it is logical to predict that this trend will increase. The City of Tempe is now in a unique position to capitalize on this cultural shift and significantly increase bicycling levels. In order to do so, it is important to understand what makes people bicycle in the first place. This thesis examined the City of Groningen, Netherlands to answer this question. The findings of this thesis are based on Theory of Planned Behavior (TPB), which suggests that the built environment influences perceived behavioral control and attitudes towards certain modes of transportation. In conclusion, the behavioral control and attitudes towards bicycling in Groningen must be very positive because of the city's wide range of "carrot" and "stick" policies, which render bicycling as the most logical mode of transportation. The recommendations of this thesis agree with those suggested in past research which advise that unless Tempe can implement more Groningen-style "carrot" and "stick" measures, it may be difficult to convince residents in Tempe to get out of the car and onto the bike.

Unfortunately implementing these policies in Tempe and other American cities is easier said than done. Despite the recent shift back into the city center, there are still millions of Americans who prefer to live in suburbs where the car is the only transportation option. Although many cities (including Tempe) have made some progress on implementing "carrot" policies through safer bicycle infrastructure and integration

with public transportation, many of these measures used to encourage cycling have been far more limited than those used in European cities (Pucher & Buehler, 2006).

Additionally, the political clout towards enacting “stick” policies in American cities is weak. Many Americans oppose higher taxes and as a result, policy makers at the local, state and national level have heeded to these demands by ensuring low taxes on fuel, car purchases and parking. Therefore, because of these obstacles, the future of raising bicycling rates to meaningful levels in American cities is uncertain. If the cultural shift of Millennials moving back into city centers continues to grow, then perhaps implementing these policies will become more politically feasible in the future. Therefore further monitoring of the Millennial housing trend is necessary in order to understand the variable political clout surrounding “carrot” and “stick” policies.

Additional research on cycling would benefit from greater involvement of the different levels of government in the United States. Conducting surveys and gathering travel information from the city, county, state and federal level to understand bicycle perceptions would foster greater understanding of how “carrot” and “stick” policies can be implemented at these levels and be tailored to each city’s unique needs.

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APPENDIX A
SURVEY (ENGLISH VERSION)



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To whom it may concern

Date
October, 2014

Our reference

Hello. I am Kevin Rayes, a master student from Arizona State University in Phoenix, Arizona, United States of America. I am doing my master thesis research at the University of Groningen. I want to learn about the reasons why people choose to use the bicycle or drive the car in Groningen City. Would you please be so kind to answer my questions? It will only take 6 to 8 minutes of your time. Your help would be greatly appreciated.

1. What is the purpose of this trip?
(please give the primary purpose)
 - going to work
 - going to school
 - going out to a restaurant or bar
 - shopping/groceries
 - recreation
 - exercise
 - other: _____

2. What is your mode of transportation
for this specific trip?
(please ignore walking)
 - bicycle
 - automobile
 - automobile + bus
 - automobile + train
 - bicycle + bus
 - bicycle + train

3. How many times per week do you
use this mode of transportation for
this purpose?
 - rarely - 1x per week
 - sometimes - 2x or 3x per week
 - often - 4 to 7x per week
 - very often - 8 or more times per week

4. What is the one-way distance of this
trip?

approximately _____ km

5. How much time does this trip
normally take?

approximately _____ minutes

If you used the bicycle today for this trip, please answer the questions of part A, then part C.

Part B

1. What is your postcode? (4 numbers, 2 letters) _____

2. What is your age? 18 – 29
 30 – 49
 50 – 64
 65 or older

3. Gender? male
 female

4. What are you? a working person (with a job)
 a student (at RUG or Hanze)
 a pupil/student (not RUG or Hanze)
 retired
 not working, not looking for a job
 not working, looking for a job

Thank you very much for your cooperation! In case you have any questions, please do not hesitate to contact me at k.rayes@utexas.edu

APPENDIX B
SURVEY (DUTCH VERSION)



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Aan de geadresseerde

Date
Oktober, 2014

Our reference

Hallo, mijn naam is Kevin Rayes. Ik ben een student van Arizona State University uit Phoenix in de Verenigde Staten. Ik werk aan mijn afstudeerscriptie aan de Rijksuniversiteit Groningen. Ik wil graag begrijpen waarom mensen kiezen voor de fiets of de auto in de stad Groningen. Zou u zo vriendelijk willen zijn mijn vragen te beantwoorden? Het kost u maar 6 tot 8 minuten. Uw bijdrage aan mijn onderzoek stel ik enorm op prijs.

1. Wat is het doel van deze verplaatsing?
(verplaatsing = de rit die u per fiets of per auto maakte op het moment dat ik u om uw medewerking vroeg)
Gelieve het belangrijkste doel aan te geven
- naar werk gaan
 uitgaan (naar restaurant of café)
 winkelen/boodschappen doen
 ontspanning
 lichamelijke oefening/bewegen
 anders, nl.: _____
2. Welk vervoermiddel gebruikt u voor deze verplaatsing?
(uitgezonderd lopen/wandelen)
- fiets
 auto
 auto + bus
 auto + trein
 fiets + bus
 fiets + trein
3. Hoe vaak per week gebruikt u dit vervoermiddel voor dit doel?
- zelden - 1x per week
 soms - 2x of 3x per week
 vaak - 4x tot 7x per week
 zeer vaak - 8 of meer keer per week
4. Wat is de enkele reis afstand van deze verplaatsing?
ongeveer _____ km
5. Hoe veel tijd kost deze verplaatsing normaal?
ongeveer _____ minuten

Als u vandaag de fiets gebruikte voor deze verplaatsing, wilt u dan de vragen van deel A beantwoorden, en daarna deel B?

Deel A – Als u vandaag de fiets voor deze verplaatsing gebruikte 91

1. Hoe veel invloed heeft **veilige fiets infrastructuur** gehad op uw beslissing om te fietsen? Infrastructuur is bijvoorbeeld een vrijliggend fietspad, en stoplichten voor fietsen bij kruispunten.

1	2	3	4	5
Geen invloed				Heel veel invloed

2. Hoe veel invloed heeft **de tijd die het kost om uw bestemming te bereiken** gehad op uw beslissing om te fietsen?

1	2	3	4	5
Geen invloed				Heel veel invloed

3. Hoe veel invloed heeft de **afstand tot uw bestemming** gehad op uw beslissing om te fietsen?

1	2	3	4	5
Geen invloed				Heel veel invloed

4. Hoe veel invloed heeft de **onderlinge afstemming tussen openbaar vervoer en fietsen** gehad op uw beslissing om te fietsen? Het gaat hier bijvoorbeeld om de mogelijkheid een fiets mee te nemen in de trein, en parkeerplekken voor fietsen bij trein- en busstation.

1	2	3	4	5
Geen invloed				Heel veel invloed

5. Hoe veel invloed heeft de **beschikbaarheid van fietsparkeerplekken dicht bij uw bestemming** gehad op uw beslissing om te fietsen?

1	2	3	4	5
Geen invloed				Heel veel invloed

6. Hoe veel invloed heeft het **risico van diefstal van uw fiets** gehad op uw beslissing om te fietsen?

1	2	3	4	5
Geen invloed				Heel veel invloed

7. Hoe veel invloed heeft **lichamelijke inspanning (gezond bewegen)** gehad op uw beslissing om te fietsen?

1	2	3	4	5
Geen invloed				Heel veel invloed

Deel B

1. Wat is uw postcode? (4 cijfers, 2 letters) _____

2. Wat is uw leeftijd? 18 – 29
 30 – 49
 50-64
 65 of ouder

3. Uw geslacht? Man
 Vrouw

Wat bent u? werkend (iemand met een baan)
 een student (van RUG of Hanze)
 met pensioen
 niet werkend en niet op zoek naar een baan
 niet werkend en op zoek naar een baan

Hartelijk dank voor uw medewerking!

Als u vragen heeft, aarzelt u dan niet om mij een email te sturen: k.rayes@utexas.edu

APPENDIX C
INTERVIEW CANDIDATES

Interview 1: Dr. Sierdjan Koster is an assistant professor in Economic Geography at the University of Groningen.

Interview 2: Dr. Gregory Ashworth is a world-renowned researcher in his field of expertise: management of cultural heritage, urban tourism, urban planning, city marketing and leisure management.

Interview 3: Dr. G. de Roo is a Professor of Spatial Planning in the Faculty of Spatial Sciences at the University of Groningen. He is responsible for various fields of research, most notably concerning interventions within the physical environment.

Interview 4: Dr. F. Niekerk is a University Lecturer at the University of Groningen. She specializes in environmental & infrastructure planning and transportation.

Interview 5: Dr. Wendy Tan is an assistant professor of infrastructure and transportation planning at the University of Groningen. Her expertise includes transit-oriented development, transportation policies and processes, institutions and institutional change in planning, sustainable development in megacities and strategic planning at regional and metropolitan levels.

Interview 6: Mr. Hans Vissers is a mobility advisor for the city of Groningen. He advises city council colleagues on the topic of traffic and transportation. He is involved in the most complex and big projects in the Municipality such as reconstruction of the central station. Furthermore he is involved in the management of public transportation between the private and public sector.

Interview 7: Mr. Eric Iwerson is a transportation planner for the city of Tempe. He focuses on the long-range vision for transportation and implement projects from the list into construction.

Interview 8: Dr. Aaron Golub is an associate professor in the School of Geographical Sciences and Urban Planning at Arizona State University. His work focuses on urban transportation systems and activism and support of alternatives to the automobile including the bicycle.

Interview 9: Dr. Elizabeth Larson is a lecturer in the School of Geographical Science and Urban Planning at Arizona State University where she teaches human, regional and environmental geography. She also worked in the municipal government for the city of Scottsdale for several years.